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THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES.

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 150 ELEGANT ENGRAVINGS,

BY

MESSRS. LOWRY AND SCOTT.

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1809.

PREFACE.

THE experience of more than a century has eminently proved the advantages of such works as exhibit, under an alphabetical arrangement, the complete circle of human knowledge. Dictionaries of language, of general terms, and of particular branches of science and art, have been multiplied by the labours of men fully qualified to display the subjects they have undertaken to discuss: and the first characters in the various nations of Europe have been proud to rank their names and unite their exertions in the production of immense works, containing every subject which can engage the intellectual research or active occupation of man. The order of the alphabet has been so skilfully combined with that order which is indicated by the natural relations of the materials, that works of this description have been received with the most striking approbation; and, notwithstanding the great labour and expense required to keep pace with the rapid improvements and discoveries of modern times, the number of Dictionaries of all descriptions has been so great, that it would be difficult, and perhaps useless, even to name them, and point out their respective merits.

From the great Encyclopedias, each of which may be said to constitute an entire library, to those smaller compositions intended for mere reference:—from the hurried compilations of book-makers to those elaborate and luminous works in which men of the highest reputation have recorded their comprehensive views, and their most striking discoveries, it is not difficult to observe and deduce the distinct and separate utilities of each, and the duties to be expected from the editors and proprietors of such undertakings. Among the most obvious of these it is indispensable that a new work should be called for by circumstances which point out advantages of size, plan, and materials not before adopted, and that the means to be employed, in the actual performance, should be such as must determine its worth and authority with every description of readers.

We are already in possession of the large Cyclopedia of Dr. Rees, which has advanced to its twelfth volume, by a progress that insures its regular completion, and in a style of execution which is truly honourable to the skill and diligence of those who have undertaken it; to the activity and enterprize of the Proprietors, and to a nation which has ever taken the lead in science and the arts. On the smaller Dictionaries it is needless to enlarge. After various deliberate consultations between the Proprietors, the Editor, and the principal gentlemen engaged in the different departments, it was concluded that *a new Dictionary, appropriated exclusively to the*

Arts and Sciences, and containing a dense, accurate, and ample exhibition of our whole knowledge respecting them, might with the greatest advantage be comprehended in the limits of six large octavo volumes. It was accordingly decided that the undertaking should be entered upon with vigour and activity, at the same time that the utmost attention should be paid to the means by which alone it was possible to insure the value of the intended work. The year preceding its appearance was employed in digesting the plan, establishing correspondencies, investigating the various sources of information, and settling the order and disposition of the materials; and it was not until after those materials were in considerable forwardness, and the whole arrangement was before the Editor, that the Proprietors thought themselves enabled to disclose their views, and express their confidence in the public support.

If the value of a composition of the magnitude and extent of the British Encyclopedia could be seen at once by a cursory or even by a diligent examination; or if the variety of subjects it comprehends would admit of the supposition, that a decision on its merits could be made in a reasonable time, by general readers, it might then be consistent with the becoming reserve of men, speaking of their own labours, to submit them wholly to the ultimate voice of a discerning public. But when by compilation from the works of authors, standing high in celebrity for knowledge and for talents; by the occasional abridgement and elucidation of the products of

these researches; and by the insertion, in almost every sheet, of treatises or disquisitions composed expressly for the purpose, the whole composition of a Dictionary of Science shall bear the marks of originality, it becomes a duty in the Editor, with regard to himself and the other writers, that he should, to a certain extent, point out what has been done in this respect.

It would be truly gratifying to the Editor if he might attempt in this place to express his sentiments of the treatises which have passed under his view in the conduct and disposition of the present work, and declare his obligations individually to each of the writers who have honoured him with their assistance in the completion of the undertaking; but he fears that the language of approbation which he would in justice feel himself compelled to use, might be misconstrued into an unbecoming endeavour to enhance, beyond its merits, the value of the publication. Some of the authors of the British Encyclopedia have chosen to reserve their names. The Editor has written and composed upwards of two hundred articles on Chemistry, Natural Philosophy, and Mechanics, and practical subjects relating to them, besides several of the lives of great men. The Mathematical Articles, including the mixed subjects of Astronomy, Optics, Phonics, Statics, and many others, were drawn up by a popular author who is well known for his writings on those subjects. The article Conic Sections was written by JAMES IVORY, Esq. of the Royal Military College of Marlow. To the Rev. Dr. CARPENTER, of

Exeter, our readers are indebted for the articles Grammar, Language, Mental and Moral Philosophy, Understanding, the origin of Writing, and many others connected with the philosophy of the mind. For the articles Criticism, History, Poetry, and Rhetoric, our obligations are due to the Rev. Wm. Shepherd, author of the Life of Poggio Bracciolini. To J. J. Grellier, Esq. of the Royal Exchange Insurance Company, are to be ascribed many valuable articles on Political Economy, the Doctrine of Annuities, Reversions, Assurance, &c.

In our Medical Department, the articles Dietetics, Diseases and Treatment of Infancy, Materia Medica, Medicine, Midwifery, and Pharmacy, were written by J. M. Good, Esq. the learned translator of "Lucretius," and author of many works in medicine, and the sciences connected with it. Those on Anatomy, Comparative Anatomy, the Natural History of Man, Physiology, Surgery, &c. were drawn up by W. Lawrence, Esq. of St. Bartholomew's Hospital.

To a very ingenious pupil of Dr. Smith, the celebrated President of the Linnean Society, we are indebted for the introductory treatise on Botany. Dynamics, Hydraulics, Music, Fortification, Perspective, and many other articles in Mathematics and Experimental Philosophy; and also those on Farriery and Gardening, were composed by Capt. Williamson, a gentleman well known to the literary and philosophical world. The articles Distillery and Galvanism were written by Mr. Sylvester

of Derby, whose discoveries in the latter new and promising department of experimental research are well known to philosophers. To W. Y. Ottley, Esq. we acknowledge ourselves indebted for the article Painting. And to Mr. J. P. Malcolm, author of "The Antiquities of London," are to be ascribed those on Heraldry, Topography, and other articles connected with the Arts.

James Parkinson, Esq. author of an elaborate and extensive work on the "Organic Remains of a former World," composed the articles Geology, Oryctology, Rocks, and Shells, which appear in this Dictionary. Those on Dyeing, and on the Manufacture of Cotton deduced from actual observation, with several others relating to practical Mechanics, and subjects of a mixed nature, were furnished by W. Boswell, Esq.: and those on Weaving and Short-hand by Mr. Nightingale. Mr. Peter Nicholson is the author of the treatises on Architecture and Building; and the processes of particular Arts and Manufactures were either communicated by professional men, or in various instances drawn up under their inspection.

When the reader shall have directed his attention to the ample quantity of original and excellent matter contained in the articles here pointed out, besides others more concise, and interspersed through the work, he will be enabled to form some judgment of its utility and comparative cheapness.

It is now a year since the Proprietors and Conductors of this work solicited the public encouragement, with a full determination to spare no exertions in performing the duties required in their arduous undertaking. The event, they trust, has gratified their expectation. The British Encyclopedia was commenced, has been regularly continued, and is now completed in six handsome volumes, agreeably to the Prospectus. In the typographical execution of this Dictionary, and in the engravings with which it is illustrated, they feel confident they may claim a superiority over every other work of the same kind. An extensive sale has already given proof of the approbation they have laboured to deserve; and they trust, that as the British Encyclopedia continues to increase in circulation, it will maintain the reputation it has already acquired.

December 21, 1808.

THE

BRITISH ENCYCLOPEDIA.

A The first letter of the alphabet, and one of the five vowels, is pronounced variously; sometimes open, as in the words *talk, war;* and at others close, as in *take, wake.*

A is also used, on many occasions, as a character, mark, or abbreviation. Thus, in the calendar, it is the first of the dominical letters: among logicians, it denotes an universal affirmative proposition: as a numeral, A signified 1 among the Greeks; but among the Romans, it denoted 500, and with a dash over it, thus $\bar{A}$, 5000. A, $\bar{a}$, or $\bar{aa}$, among physicians, denote *ana*, or an equal weight, or quantity, of several ingredients.

AAM, or Haam, a liquid measure used by the Dutch, equal to 288 pints English measure.

ABACK, in sea language, signifies the situation of the sails when their surfaces are flatted against the mast. They may be brought *aback*, either by a sudden change of wind, or an alteration in the ship's course. They are laid aback to effect an immediate retreat, without turning either to the right or left, to avoid some immediate danger in a narrow channel, or when she has advanced beyond her station in the line of battle.

ABACUS, in architecture, the uppermost member of the capital of a column. See Architecture.

Abacus, among ancient mathematicians, was a table strewed over with dust, or sand, on which they drew their figures or schemes.

Abacus, in arithmetic, an instrument for facilitating operations by means of counters. Its form is various; but that chiefly used in Europe is made by drawing parallel lines, distant from each other at least twice the diameter of a counter; which, placed on the lowermost line, signifies 1; on the second, 10; on the third, 100; on the fourth, 1000; and so on. Again, a counter, placed in the spaces between the lines, signifies only the half of what it would do on the next superior line.

Abacus *pythagoricus*, a multiplication-table, or a table of numbers ready cast up, to facilitate operations in arithmetic.

Abacus *logisticus*, is also a kind of multiplication-table, in form of a right-angled triangle.

Abacus *harmonicus*, among musicians, denotes the arrangement of the keys of a musical instrument.

Abacus, *Grecian*, an oblong frame, over which are stretched several brass wires, strung with little ivory balls, by the various arrangements of which all kinds of computations are easily made.

Abacus, *Chinese*, or Shwanpan, consists of several series of beads strung on brass wires, stretched from the top to the bottom of the instrument, and divided in the middle by a cross piece from side to side. In the upper space every string has two beads, which are each counted for five; and in the lowest space every string has five beads, of different values, the first being counted as 1, the second as 10, the third as 100, and so on.

ABAFT, in sea-language, a term applied to any thing situated towards the stern of a vessel: thus a thing is said to be abaft the fore-mast, or main-mast, when placed between the fore-mast, or main-mast, and the stern.

Abaft *the beam*, denotes the relative situation of any object with the ship, when the object is placed in any part of that arch of the horizon which is contained between a line at right angles with the keel, and that point of the compass which is directly opposite the ship's course.

ABAS, a weight used in Persia for weighing pearls, being one-eighth part lighter than the European carat.

ABASED, in heraldry, is said of the wings of eagles, &c. when the tip looks downwards to the point of the shield, or when the wings are shut; the natural way of bearing them being spread.

ABATE, in law, signifies to break down or destroy, as to abate a nuisance, and to abate a castle. It means to defeat and overthrow, on account of some error or exception.

ABATEMENT, in heraldry, something added to a coat of arms, in order to lessen its true dignity, and point out some imperfection or stain in the character of the person who bears it.

Abatement, in law, signifies the rejecting a suit, on account of some fault either in the matter, or proceeding. Hence, plea in abatement is some exception alleged, and proved, against the plaintiff's writ, declaration, &c. and praying that the plaint may abate or cease; which being granted, all writs in the process must begin *de novo*.

ABATOR, in law, one who enters into a house or lands, void by the death of the last possessor, before the true heir; and thereby keeps him out, till he brings the writ *intrusione*.

ABDOMEN, in anatomy, the lower part of the trunk of the body, reaching from the thorax to the bottom of the pelvis. See Anatomy.

ABDOMINALES, in natural history, an order of fishes, having ventral fins placed behind the pectoral in the abdomen, and the branchia ossiculated. This order comprehends sixteen genera, viz.

Amia	Cobitis	Atherina
Clupea	Esox	Cyprinus
Elops	Loricaria	Exocoetus
Fistularia	Salmo	Mugil
Polynemas	Teuthis	Silurus
Argentina		

ABDUCTOR, or Abducent, in anatomy, a name given to several muscles on account of their serving to withdraw, open, or pull back the parts to which they are fixed. See Anatomy.

ABERRATION, in astronomy, an apparent motion of the heavenly bodies, produced by the progressive motion of light and the earth's annual motion in her orbit. Since light proceeds always in right lines, when its motion is perfectly undisturbed, if a fine tube were placed so as to receive a ray of light, passing exactly through its axis when at rest, and then, remaining in the same direction, were moved transversely with great velocity, it is evident that the side of the tube would strike against the ray of light in its passage, and that, in order to retain it in the axis, the tube must be inclined, in the same manner as if the light, instead of coming in its actual direction, had also a transverse motion in a direction contrary to that of the tube. The axis of a telescope, or even of the eye, may be considered as resembling such a tube, the passage of the light through the refracting substances not altering the necessary inclination of the axis. In various parts of the earth's orbit, the aberration of any one star must be different in quantity and in direction; it never exceeds 20″ each way, and therefore insensible in common observations. If AB and AC (Plate Acoustics, &c. fig. 1,) represent the comparative velocity of light and of the earth, in their respective directions, a telescope must be placed in the direction BC in order to see the star D, and the star will appear at E. This discovery was made by Dr. Bradley, in his observations to determine the annual parallax of the fixed stars, or that which arises from the motion of the earth in its orbit round the sun.

Aberration *of the planets*, is equal to the geocentric motion of the planet, the space which it appears to move, as seen from the earth, during the time that light employs in passing from the planet to the earth. Thus with regard to the sun, the aberration in longitude is constantly 20″, which is the space moved by the earth in the time 8′ 7″, which is the time that light takes to pass from the sun to the earth. Hence the distance of the planet from the earth being known, it will be, as the distance of the sun is to the distance of the planet, so is 8′ 7″ to the time of light passing from the planet to the earth; then computing the planet's geocentric motion in this time, will give the aberration of the planet, whether it be in longitude, latitude, right ascension, or declination. The aberration will be greatest in longitude, and but very small in latitude, because the planets deviate very little from the plane of the

ecliptic. In Mercury it is only $4\frac{1}{3}''$, and much less in the other planets. The aberration in declination and right ascension depends on the situation of the planet in the zodiac. The aberration in longitude, being equal to the geocentric motion, will be more or less, according as that motion may be. It will be least when the planet is stationary; and greatest in the superior planets, when they are in opposition; but in the inferior planets the aberration is greatest at the time of their superior conjunction.

ABERRATION, in optics, a deviation of the rays of light, when reflected, whereby they are prevented from meeting in the same point. Aberrations are of two kinds; one arising from the figure of the reflecting body, the other from the different refrangibility of the rays themselves: this last is called the Newtonian aberration, from the name of the discoverer.

ABETTOR, or ABBETTOR, in law, the person who promotes or procures a crime to be committed: thus, an abettor of murder is one who commands or counsels another to commit it. An abettor, according as he is present or absent at the time of committing the fact, is punishable as a principal or accessary. See ACCESSARY.

An abettor is the same with one who is deemed *art and part*, by the law of Scotland.

ABEYANCE, in law, is that which is in expectation, remembrance, and intendment of law. By a principle of law, in every land there is a fee simple in somebody, or it is in abeyance; that is, though at present it be in no man, yet it is, in expectancy, belonging to him that is next to enjoy the land. Where no person is seen or known, in whom the inheritance can vest, it may be in abeyance, as in limitation to several persons, and the survivor, and the heirs of such survivor, because it is uncertain who will be the survivor, yet the freehold cannot, because there must be a tenant to the præcipe always.

ABJURATION, in law, is used for renouncing, disclaiming, and denying the Pretender to have any manner of right to the throne of these kingdoms: and that upon oath, which is required to be taken upon divers pains and penalties by many statutes, particularly 1 W. and M. 13 W. III. 1 Anne, 1 Geo. I.

ABOLITION, in law, denotes the repealing any law or statute, and prohibiting some custom, ceremony, &c. Sometimes also it signifies leave granted by the king, or a judge, to a criminal accuser to forbear any farther prosecution.

Abolition is also used by ancient civilians and lawyers, for desisting from, or annulling, a legal prosecution; for remitting the punishment of a crime; and for cancelling or discharging a public debt.

ABOMASUS, ABOMASUM, or ABOMASIUS, in comparative anatomy, names used for the fourth stomach of ruminating beasts, or such as chew the cud. These have four stomachs, the first of which is called *venter;* the second, *reticulum;* the third, *omasus;* and the fourth, *abomasus.* This last is the place where the chyle is formed, and from which the food descends immediately into the intestines.

ABORTION, in medicine, an untimely or premature birth of a fœtus, otherwise called a miscarriage; but if this happen before the second month of pregnancy, it is only called a false conception. See MEDICINE, MIDWIFERY, &c.

ABORTION, in law, if caused by giving a potion to, or striking a pregnant woman, was murder, but now is said to be a great misprision only, and not murder, unless the child be born alive, and die thereof.

ABOUT, in military affairs, a word to express the movement by which a body of troops changes its front, by facing according to any given word of command.

ABRA, a silver coin of Poland, nearly equivalent to the English shilling. See COIN.

ABREAST, a sea term, expressing the situation of two or more ships, that lie with their sides parallel to each other, and their heads advanced. When the line of battle at sea is formed *abreast*, the whole squadron advances uniformly. *Abreast within the ship*, denotes on a line with the beam, or by the side of any object aboard.

ABRIDGMENT, in law, the shortening a count, or declaration: thus, in assize, a man is said to abridge his plaint, and a woman her demand in action of dower, if any land is put therein, which is not in the tenure of the defendant; for on a plea of non-tenure, in abatement of the writ, the plaintiff may leave out those lands, and pray that the tenant may answer to the remainder. The reason is, that these writs run in general, and therefore shall be good for the rest.

ABROMA, in botany, a word signifying *not fit for food*, is used in opposition to Theobroma, as a genus of plants belonging to the natural order of Columniferæ, and the eighteenth class of Polyadelphia Dodecandria. There are two species, viz. the

the maple-leaved abroma, which is a tree with a straight trunk, yielding a gum when cut, and filled with a white pith like the elder; it flowers from June to October, and its fruit ripens in September and October; it is a native of New South Wales and the Philippine islands, was introduced into Kew gardens about 1770, and is a hot-house plant, requiring great heat, and much water:—and Wheler's Abroma, so called by Koenig, in compliment to Edward Wheler, Esq. of the Supreme Council in Bengal; this is a shrub with a brown bark, a native of the East Indies, and is not known in Europe. There is but one of the species known in Europe, which is propagated with us by cuttings. The plant requires a strong heat, and abundance of water. The seeds rarely arrive at a state fit for propagation.

ABRUS, in botany, from a Greek word signifying soft or delicate, so called from the extreme tenderness of the leaves, is a genus of the natural order of Leguminosæ, and the seventeenth class of Diadelphia Decandria. There is one species, viz. the Abrus precatorius. It grows naturally in both Indies, Guinea, and Egypt. It is a perennial plant, rising to the height of eight or ten feet. Its leaflets have the taste of liquorice, whence it is called, in the West Indies, *Jamaica wild liquorice*, and used for the same purpose. There are two varieties, one with a white, and the other with a yellow seed. The seeds are commonly strung, and worn as ornaments in the countries where the plant grows wild; and they are frequently brought to Europe from Guinea, and the East and West Indies, and wrought into various forms with other hard seeds and shells. They are also used for weighing precious commodities, and strung as beads for rosaries, whence the epithet precatorius. They are frequently thrown, with other West Indian seeds, on the coast of Scotland. This plant was cultivated by Bishop Compton, at Fulham, before 1680. It is propagated by seeds, sown on a good hot-bed in spring, and previously soaked for twelve or fourteen hours in water. When the plants are two inches, each of them should be transplanted into a separate pot of light earth, and plunged into hot-beds of tanner's bark, and shaded from the sun. They will flower the second year, and sometimes ripen their seeds in England.

ABSCESS, in medicine and surgery, an inflammatory tumour, containing purulent matter. See SURGERY.

ABSCISSE, in conic sections, the part of the diameter of a curve line, intercepted between the vertex of that diameter and the point where any ordinate or semi-ordinate to that diameter falls. From this definition it is evident, that there are an infinite number of variable abscisses in the same curve, as well as an infinite number of ordinates.

In the parabola, one ordinate has but one abscisse; in an ellipsis, it has two; in an hyperbola, consisting of two parts, it has also two; and in curves of the second and third order, it may have three and four. See CONIC SECTIONS.

ABSCISSION, in rhetoric, a figure of speech, whereby the speaker stops short in the middle of his discourse: e. g. one of her age and beauty, to be seen alone, at such an hour, with a man of his character. I need say no more.

ABSINTHIUM. See ARTEMISIA.

ABSORBENTS, in the materia medica, such medicines as have the power of drying up redundant humours, whether applied to ulcers, or taken inwardly. See MATERIA MEDICA, and PHARMACY.

ABSORBENT *vessels*, in anatomy, are those which take up any fluid from the surface of the body, or of any cavity in it, and carry it into the blood. They are denominated according to the liquids which they convey, as *Lacteals*, or *Lymphatics*; the former conveying chyle, a milky fluid, from the intestines, the latter lymph, a thin pellucid liquor, from the places whence they take their origin. The lymphatics also take up any fluids that are extravasated, and likewise substances rubbed on the skin, as mercury, and convey them into the circulation.

ABSTRACT *idea*, among logicians, the idea of some general quality or property considered simply in itself, without any respect to a particular subject: thus, magnitude, equity, &c. are abstract ideas, when we consider them as detached from any particular body or person. Various controversies have been maintained respecting the existence of abstract ideas; but all these disputes seem to be merely verbal. It is certainly impossible to possess an idea of an animal which shall have no precise colour, figure, magnitude, or the like; but it is an useful artifice of the understanding to leave these out in our general reasonings. Thus it is that the *a*, *b*, *c*, &c. of the algebraists are usefully applied to denote numbers, though undoubtedly they are only general signs.

ABUCCO, ABOCCO, or ABOCCHI, a weight used in the kingdom of Pegu.

ABUNDANT *numbers*, those whose

parts added together make more than the whole number: thus the parts of 20, make 22, viz. 1, 2, 4, 5, 10.

ACACIA, in botany, a species of mimosa. See MIMOSA.

ACACIA, in the materia medica of the ancients, a gum made from the Egyptian acacia-tree, and thought to be the same with our gum-arabic.

ACADEMICS, a sect of philosophers who followed the doctrine of Socrates and Plato, as to the uncertainty of knowledge, and the incomprehensibility of truth.

Academic, in this sense, amounts to much the same with Platonist; the difference between them being only in point of time. They who embraced the system of Plato, among the ancients, were called Academici; whereas those who have done the same, since the restoration of learning, have assumed the denomination of Platonists. We usually reckon three sects of Academics; though some make five. The ancient Academy was that which was founded by Plato; and consisted of those followers of this eminent philosopher, who taught the doctrine of their master without mixture or corruption. The first of these was Speusippus; he was succeeded by Xenocrates. After his death the direction of the academy devolved upon Polemo, and then upon Crates, and terminated with Crantor. After the death of Crates, a new tribe of philosophers arose, who, on account of certain innovations in their manner of philosophising, which in some measure receded from the Platonic system, without entirely deserting it, have been distinguished by the appellation of the Second, or Middle Academy. The first preceptor who appears in this class, and who, in consequence of the innovations which he introduced into the Platonic school, has been commonly considered as the founder of this academy, is Arcesilaus. Before the time of Arcesilaus, it was never denied, that useful opinions may be deduced from the senses. Two sects arose about this time, which threatened the destruction of the Platonic system; one was founded by Pyrrho, which held the doctrine of universal scepticism, and the other by Zeno, which maintained the certainty of human knowledge, and taught with great confidence a doctrine essentially different from that of Plato. In this situation, Arcesilaus thought it necessary to exercise a cautious reserve with regard to the doctrine of his master, and to conceal his opinions from the vulgar, under the appearance of doubt and uncertainty. Professing to derive his doctrine concerning the uncertainty of knowledge from Socrates, Plato, and other philosophers, he maintained, that though there is a real certainty in the nature of things, every thing is uncertain to the human understanding, and consequently that all confident assertions are unreasonable. He thought it disgraceful to assent to any proposition, the truth of which is not fully established, and maintained that, in all questions, opposite opinions may be supported by arguments of equal weight. He disputed against the testimony of the senses, and the authority of reason; acknowledging at the same time, that they furnish probable opinions sufficient for the conduct of life. However, his secret design seems to have been to establish the doctrine of Plato, that the knowledge derived from sensible objects is uncertain, and that the only true science is that which is employed upon the immutable objects of intelligence, or ideas.

After the death of Arcesilaus, the Platonic school was successively under the care of Lacydes, who is said to have founded a new school, merely because he changed the place of instruction, and held it in the garden of Attalus, within the limits of the Academic grove, and of Evander and Egesinus. Arcesilaus, however, had opposed the Stoics and other dogmatical philosophers, with such violence, and extended his doctrine of uncertainty so far, as to alarm not only the general body of philosophers, who treated him as a common enemy to philosophy, but even the governors of the state, who apprehended that his opinions would dissolve all the bonds of social virtue and of religion. His successors, therefore, found it difficult to support the credit of the academy; and Carneades, one of the disciples of this school, relinquished, at least in words, some of the more obnoxious tenets of Arcesilaus.

From this period the Platonic school assumed the appellation of the New Academy, which may be reckoned the third in order from its first establishment. It was the doctrine of this academy, that the senses, the understanding, and the imagination, frequently deceive us, and therefore cannot be infallible judges of truth; but that, from the impressions produced on the mind, by means of the senses, called by Carneades phantasies, or images, we infer appearances of truth, or probabilities. These images do not always correspond to the real nature of things, and there is no infallible method of determining when they are true or false; and conse-

quently they afford no certain criterion of truth. But, with respect to the conduct of life, and the pursuit of happiness, probable appearances are a sufficient guide, because it is unreasonable not to allow some degree of credit to those witnesses who commonly give a true report.

ACADEMY, in Grecian antiquity, a large villa in one of the suburbs of Athens, where the sect of philosophers called Academics held their assemblies. It took its name from one Academus, or Ecademus, a citizen of Athens; as our modern academies take theirs from it. This term was also used metaphorically, to denote the sect of Academic Philosophers. See ACADEMICS.

ACADEMY, in a modern sense, signifies a society of learned men, established for the improvement of arts or sciences. See SOCIETY.

ACÆNA, in botany, a genus of the Tetrandria Monagynia class and order of plants. There is but a single species, which is a Mexican plant.

ACALYPHA, in botany, a genus of plants belonging to the Monoecia Monodelphia class, and the natural order of Tricoccæ, called the Tick-fruit. There are fourteen species: the A. virginica, grows naturally in Virginia, and in Ceylon: the A. virgata is a native of the warmest countries, and grows plentifully in Jamaica; its leaves resemble those of the annual nettle, and sting as much. Most of the other species are natives of the West Indies. The plants have no beauty to recommend them, and are preserved in some botanic gardens merely on account of variety.

ACANTHA, among botanists, a name given to the prickles of thorny plants.

ACANTHA is also used by zoologists for the spines of certain fishes, as those of the echinus marinus, &c.

ACANTHACEOUS, among botanists, an epithet given to all the plants of the thistle kind, on account of the prickles with which they are beset.

ACANTHONOTUS, in natural history, a genus of fishes of the order Abdominales: the generic character is, body elongated, without dorsal fin: spines several, on the back and abdomen. There is but one species, the nasus, about 30 inches long, a native of the East Indies. The eyes are large, and the nostrils conspicuous: the body, which is of a moderate width for about the third of its length, gradually decreases or tapers towards the extremity: both head and body are covered with small scales, and are of a bluish tinge, with a silvery cast on the abdomen: the pectoral fins are brown, and of a moderate size: the ventral rather small, and of a similar colour: the lateral line is strait, and situated nearer to the back than to the abdomen: along the lower part of the back are ten strong but short spines, and beneath the abdomen twelve or thirteen others, which are followed by a small anal fin. (See plate I. Ichthyology, fig. 1.)

ACANTHURUS, in natural history, a genus of fishes, of the order Thoracici, of which the gen. character is, teeth small, in most species lobated: tail aculeated on each side: general habit and appearance like the genus Chætodon, which see. This genus consists of such species of the Linnæan genus Chætodon, as, in contradiction to the principal character of that genus, have moderately broad and strong teeth, rather than slender and setaceous ones: they are also furnished on each side the tail with a strong spine. There are twelve species, of which the principal is A. unicornis; this is the largest of the genus, growing to the length of three feet or more. It is a native of the Indian and Arabian seas, in the latter of which it is generally seen in large shoals of two or three hundred each, swimming with great strength, and feeding principally on different kinds of sea-weed. This fish was described by Grew, in his Museum of the Royal Society, under the name of the Lesser Unicorn Fish. Fine specimens are to be found in the British and Leverian museums.

ACANTHUS, BEAR'S BREECH, or BRANK-URSINE, in botany, a genus of the Didynamia Angiospermia class, and belonging to the natural order of Personatæ. There are ten species: 1. The smooth acanthus, with white flowers, proceeding from about the middle to the top of the stalk, is the species used in medicine under the name of Branca ursina, or Brank-ursine. It is a native of Italy, about Naples, of Sicily, Provence, and the islands of the Archipelago, and is cultivated in our gardens, and flowers in June and July. Turner (in his Herbal in Hort. Kew.) informs us, that it was cultivated in Sion gardens so long ago as the year 1551. The leaves, and particularly the roots, abound with a soft, insipid mucilage, which may be readily extracted, either by boiling, or by infusion. Rectified spirit digested on the leaves, extracts from them a fine deep green tincture, which is more durable than that which is communicated to spirit by other herbs. Brank-ursine is seldom or ever used medicinally in this country. But

where it is common, it is employed for the same purposes to which the Althæa, or marsh-mallow, and other mucilaginous vegetables are applied among us. In foreign countries the cow-parsnip is said to be substituted for it, though it possesses very different properties. The leaves of this species of acanthus accidentally growing round a basket covered with a tile, gave occasion to Callimachus to invent the Corinthian capital in architecture. 2. The thistle-leaved acanthus was found by Sparrman at the Cape of Good Hope, and has many leaves, proceeding immediately from the root, resembling those of the thistle. 3. The prickly acanthus grows wild in Italy and Provence, and flowers from July to September. Its leaves are divided into segments, terminated with a sharp spine, which renders this plant troublesome to those who handle it. 4. The acanthus of Dioscorides, as Linnæus supposes it to be, grows naturally in the East, on Lebanon, &c. 5. The holly-leaved acanthus is an evergreen shrub, about four feet high, and separating into many branches, with leaves resembling those of the common holly, and bearing white flowers, similar to those of the common acanthus, but smaller. 6, 7, 8, 9. These species, viz. the entire-leaved, procumbent, forked, and Cape acanthi, are natives of the Cape of Good Hope. 10. The Madras acanthus is a native of the East Indies.

The smooth and prickly acanthi are perennial plants, and may be propagated either by seeds, which should be sown in a light dry soil towards the end of March, and left to grow, about six inches asunder, till autumn, when they should be transplanted where they are to remain; or by roots, which may be planted either in spring or autumn for the third sort; but the others must only be removed in the spring, because if they are transplanted in autumn, they may be in danger of being destroyed by a cold winter. These plants take deep root, and when they are once established in a garden, they cannot be easily eradicated. The 5th and 10th species are too tender to thrive out of a stove in England, and cannot be propagated, except by seeds, which do not ripen in Europe. The other sorts must be treated in the same manner with Cape plants.

ACANTHUS, in architecture, an ornament representing the leaves of the herb acanthus, and used in the capitals of the Corinthian and Composite orders. See ARCHITECTURE.

ACARNA, in botany, a genus belonging to the Syngenesia Æqualis class and order: receptacle chaffy, down feathery: calyx imbricate, invested with scales, corol. flosscular. There are seven species.

ACARUS, the tick or mite, in natural history, so called because it is deemed so small that it cannot be cut, is a genus of insects belonging to the order of Aptera, in the Linnæan system. Gmelin, in the last edition of Linnæus's system, has eighty-two species; of which, some are inhabitants of the earth, others of water; some live on trees and plants, others among stones, and others on the bodies of other animals, and even under their skin. The generic character is, legs eight: eyes two, situated on each side the head: feelers two, jointed; egg-shaped. The most familiar species are, 1. the A. siro, or common cheese-mite, which is a favourite subject for microscopic observations. This insect is covered with hairs or bristles, which resemble in their structure the awns of barley, being barbed on each side with numerous sharp-pointed processes. The mite is oviparous: from the eggs proceed the young animals, resembling the parents in all respects, except in the number of legs, which at first amount only to six, the pair from the head not making their appearance till after casting their first skin. The eggs in warm weather hatch in about a week, and the young animal may sometimes be seen for a day together struggling to get rid of its egg-shell. The mite is a very voracious animal, feasting equally upon animal and vegetable substances. It is also extremely tenacious of life; for, upon the authority of Leewenhoek, though highly discreditable to his sense of humanity, we are assured that a mite lived eleven weeks glued to a pin, in order for him to make observations on. 2. The A. exulcerans, or itch mite, is a species of considerable curiosity, on account of the structure of its limbs: it is slightly rounded, and of a flattened shape, with the thighs of the two upper pair of legs extremely thick and short: the two lower pair of legs have thick thighs proceeding from a very slender base, and are extended into a long, stout, curved, and sharp-pointed bristle. Dr. Bononio, an Italian physician, was the first who contended that the itch was occasioned by this insect, an account of which may be found in the Philosophical Transactions, No. 283. Dr. Baker is inclined to think that it constitutes the *psora*, a species of itch distinct from others confounded with it. 3. A. autumnalis, or harvest-bug, of a bright red colour, with the

abdomen beset on its hind part with numerous white bristles. It attaches itself to the skin, and is with difficulty disengaged. On the part where it fixes, it causes a tumour, about the size of a small bead, accompanied by a severe itching. The *tick* is of this species, which is to be found on dogs and other animals. Many of the acari attach themselves to insects of a larger kind, and hence they take their names, as A. coleopterous, found on the black beetle. (See plate I. Entomology, fig. 1 and 2.)

These insects, which are often very troublesome on plants, and in hot-houses, may be effectually destroyed by the following mixture. Take two ounces of soft green soap, one ounce of common turpentine, and one ounce of flour of sulphur; pour upon these ingredients a gallon of boiling water, work the whole together with a whisk, and let the mixture be used warm. This mixture may also be of use for preventing the mildew on the peach and apricot; but it should never be used on fruit-trees near the time when their fruits are ripening. A strong ley made of wood-ashes will likewise destroy the acari; but plants are greatly injured by this, and by briny and spirituous compositions.

ACAULOSE, or Acaulous, among botanists, a term used for such plants as have no *caulis*, or stem. See Caulis.

ACCEDAS *ad curiam*, in law, a writ lying where a man hath received, or fears false judgment, in a hundred-court, or court baron. It is issued out of the Chancery, and directed to the sheriff, but returnable in the King's-bench or Common-pleas. It lies also for justice delayed, and is said to be a species of the writ *Recordare*.

ACCELERATION, in mechanics, denotes the augmentation or increase of motion in accelerated bodies.

The term acceleration is chiefly used in speaking of falling bodies, or the tendency of heavy bodies towards the centre of the earth produced by the power of gravity; which, acting constantly and uniformly upon them, they must necessarily acquire every instant a new increase of motion. See Gravitation.

ACCELERATOR. See Anatomy.

ACCENT, among grammarians, is the raising or lowering of the voice in pronouncing certain syllables of words.

We have three kinds of accents, viz. the acute, the grave, and circumflex. The acute accent, marked thus (´), shews that the voice is to be raised in pronouncing the syllables over which it is placed. The grave accent is marked thus (`), and points out when the voice ought to be lowered. The circumflex accent is compounded of the other two, and marked thus (˜ or ^): it denotes a quavering of the voice between high and low. Some call the long and short quantities of syllables, accents; but erroneously.

Accent, in music, a term applicable to every modulation of the voice, both in speaking and in singing. It is to the study of this that the composer and performer should unceasingly apply; since without accent there can be no music, because there can be no expression.

ACCEPTANCE, in common law, the tacitly agreeing to some act before done by another, which might have been defeated without such acceptance. Thus if a husband and wife, seized of land in right of the wife, make a joint lease or feoffment, reserving rent, and the husband dies; after which the widow receives or accepts the rent; such receipt is deemed an acceptance, confirms the lease of feoffment, and bars her from bringing the writ *cui in vita*.

Acceptance, among merchants, is the signing or subscribing a bill of exchange, by which the acceptor obliges himself to pay the contents of the bill.

Bills payable at sight are not accepted, because they must either be paid on being presented, or else protested for want of payment.

The acceptance of bills payable at a fixed day, at usance, or double usance, &c. need not be dated: because the time is reckoned from the date of the bill; but it is necessary to date the acceptance of bills payable at a certain number of days after sight, because the time does not begin to run till the next day after that acceptance: this kind of acceptance is made thus, *Accepted such a day and year*, and signed. See Exchange.

ACCESSARY, or Accessory, in common law, is chiefly used for a person guilty of a felonious offence, not principally, but by participation; as, by advice, command, or concealment. There are two kinds of accessaries; before the fact, and after it. The first is he who commands, or procures another to commit felony, and is not present himself; for if he be present, he is a principal.

The second is he who receives, assists, or comforts any man that has done murder, or felony, whereof he has knowledge. A man may also be accessary to an accessary, by

aiding, receiving, &c. an accessary in felony. An accessary in felony shall have judgment of life and member, as well as the principal, who did the felony: but not till the principal be first attainted, and convicted, or outlawed thereon. Where the principal is pardoned without attainder, the accessary cannot be arraigned; it being a maxim in law, Ubi non est principalis, non potest esse accessorius. But if the principal be pardoned, or have his clergy after attainder, the accessary shall be arraigned. 4 and 5 W. and M. cap. 4; and by stat. 1 Anne, cap. 9, it is enacted, that where the principal is convicted of felony, or stands mute, or challenges above twenty of the jury, it shall be lawful to proceed against the accessary in the same manner as if the principal had been attainted; and notwithstanding such principal shall be admitted to his clergy, pardoned, or delivered before attainder. In some cases also, if the principal cannot be taken, then the accessary may be prosecuted for a misdemeanor, and punished by fine, imprisonment, &c. stat. ib. see stat. 5 Anne, cap. 31. In the lowest and highest offences there are no accessaries, but all are principals: as in riots, routs, forcible entries, and other trespasses, which are the lowest offences. So also in the highest offence, which is, according to our law, high treason, there are no accessaries. Cok. Littlet. 71.

ACCIDENT. See LOGIC.

ACCIPITRES, or rapacious birds, in the Linnæan system of ornithology, the first order of birds; the characters of which are, that the bill bends downwards, that the upper mandible is dilated a little on both sides towards the point, or armed with a tooth-like process, and that the nostrils are wide; the legs are short and strong: the feet are of the perching kind, having three toes forwards and one backwards; the toes are warty under the joints, with claws hooked and sharp at the points. The body, head, and neck, are musculous, and the skin very tough. The birds of this order subsist by preying on other animals, and on dead carcasses, and they are unfit for food. They live in pairs, and are monogamous; and build their nests in lofty situations. The female is generally larger and stronger than the male, and usually lays four eggs at a time. This order corresponds to that of Feræ, and comprehends four genera, viz. VULTUR, FALCO, STRIX, and LANIUS, which see.

ACCOMPANIMENT, in heraldry, denotes any thing added to a shield by way of ornament, as the belt, mantling, supporters, &c.

Accompaniment is also used for several bearings about a principal one, as a saltier, bend, fess, &c.

ACCOMPLICE, in law, a person who is privy to, or aiding in, the perpetration of some crime. See ACCESSARY.

ACCORD, in law, a verbal agreement between two or more, where any one is injured by a trespass, or other offence committed, to make satisfaction to the injured party; who, after the accord is performed, will be barred in law from bringing any new action against the aggressor for the same trespass. It is safest, however, in pleading, to allege satisfaction, and not accord alone; because, in this last case, a precise execution in every part thereof must be alleged; whereas, in the former, the defendant needs only say, that he paid the plaintiff such a sum in full satisfaction of the accord, which he received.

ACCOUNTANT-*general*, in the court of Chancery, an officer appointed by act of parliament to receive all monies lodged in court, and convey the same to the bank of England for better security. The salary of this officer and his clerks is to be paid out of the interest made of part of the money; it not being allowable to take fees in this office. Counterfeiting the hand of the accountant-general is felony, without clergy, by 12 Geo. I. c. 32.

ACCOUTREMENTS, in a military sense, signify the furniture of a soldier, such as puffs, belts, pouches, cartridge-boxes, &c.

ACCROCHE', in heraldry, denotes a thing's being hooked into another.

ACER, *maple*, in botany, a genus of the Monoecia order and Polygamia class of plants, and belonging to the natural order of Trihilata. There are 25 species. See MAPLE.

ACETATES, in chemistry, a genus of salts formed by the acetic acid. They may be distinguished by the following properties: they are decomposed by heat; the acid being partly driven off, partly destroyed:—they are very soluble in water:—when mixed with sulphuric acid, and distilled in a moderate heat, acetic acid is disengaged:—when they are dissolved in water, and exposed to the open air, their acid is gradually decomposed.

ACETIC *acid*, in chemistry. This acid is employed in different states, which have been distinguished from each other by peculiar names. When first prepared, it is called

vinegar; when purified by distillation, it assumes the name of distilled vinegar, usually called *acetous* acid: when concentrated as much as possible by certain processes, it is called in the shops radical vinegar; but by chemists it is denominated *acetic* acid. One hundred parts of acetic acid are composed of

50.19	oxygen
13.94	hydrogen
35.87	carbon
100.00	

ACETITES, a genus of salts formed by the acetous acid.

ACETOUS *acid*. See ACETIC ACID.

ACHANIA, in botany, a genus of the Monadelphia Polyandria class, and the natural order of Columniferæ. There are three species, viz. the A. malvaviscus, scarlet achania, or bastard hibiscus, which is a native of Mexico and Jamaica; cultivated here in 1714 by the Duchess of Beaufort, and flowering through the greatest part of the year: the mollis, or woolly achania, a native of South America and the West India islands; found in Jamaica by Houstoun, in 1730, and introduced in 1780 by B. Bewick, Esq. and flowering in August and September: and the pilosa, or hairy achania, a native of Jamaica; introduced in 1780 by Mr. G. Alexander, and flowering in November. Achania is generally propagated by cuttings, which are planted in pots of light earth, plunged into a gentle hot-bed, and kept from the air till they take root, when they should be gradually inured to the open air. They must be preserved in winter in a moderate stove; and kept warm in summer, they will flower, and sometimes ripen fruit.

ACHERNER, in astronomy, a star of the first magnitude, in the southern extremity of the constellation Eridanus. See the article ERIDANUS.

ACHILLEA, milfoil, in botany, so called from Achilles, who is supposed to have acquired some knowledge of botany from his master Chiron; and to have used this plant for the cure of wounds and ulcers; a genus of the Syngenesia Polygamia Superflua class of plants, and of the natural order of Compositæ Discoideæ. There are 27 species, of which the most remarkable are the ptarmica, or sneezewort, M. growing wild in all the temperate parts of Europe, fouud in Britain not uncommonly in meadows, by the sides of ditches, on the balks of corn fields, in moist woods, and shady places. The shoots are put into sallets, and the roots, being hot and biting, are used for the tooth-ache, whence the plant has been called bastard pellitory, and, on account of the form of the leaf, goose-tongue: the powder of the dried leaves, used as snuff, provokes sneezing, whence the name: in Siberia a decoction of the whole herb is said to be successfully used in internal hemorrhages: of this plant there is a variety with double flowers, called batchelor's buttons; it flowers in July and August, and makes a tolerable appearance:—and the millefolium, common M. or yarrow; abundant in pastures and by the sides of roads, flowering from June to September: mixed instead of hops by the inhabitants of Dalekarlia in their ale, in order to give it an inebriating quality: recommended by Anderson in his Essays on Agriculture, for cultivation, though thought to be a noxious weed in pastures: the bruised herb fresh is recommended by Linnæus as an excellent vulnerary and styptic, and by foreign physicians in hemorrhages, and thought by Dr. Hill to be excellent in dysenteries, when administered in the form of a strong decoction. An ointment is made of it for the piles, and for the scab in sheep; and an essential oil is extracted from the flowers; but it is not used in the present practice.

ACHRAS, or SAPOTA-PLUM, in botany, a genus of the Hexandria Monogynia class, and of the natural order of Dumosæ. There are four species, viz. The mammosa, or mamme sapota, otherwise called nippled, S. or American marmelade; growing in America to the height of thirty or forty feet, with leaves a foot long, and three inches broad in the middle, cream-coloured flowers, and large oval fruit, containing a thick, luscious pulp, called natural marmelade. This tree is planted for the fruit in Jamaica, Barbadoes, Cuba, and most of the West India islands, and was cultivated here by Mr. Miller in 1739. Of this there is a variety called the bully, or nisberry bully-tree, because it is the tallest of all the trees in the woods: it is esteemed one of the best timber trees in Jamaica. 2. The sapota, which grows to the height of sixty or seventy feet, without knots or branches, and bears a round, yellow fruit, bigger than a quince, which smells well, and is of an agreeable taste. It is common at Panama, and some other places in the Spanish West Indies, but not to be found in many of the English settlements. It was cultivated here by Mr. Miller in 1739. 3. The dissecta, or cloven-flowered S. cultivated in Malabar for the fruit, which is of the form and size of an olive, having a pulp of a sweetish acid flavour. Its

leaves are used for cataplasms to tumours, bruised and boiled with the root of curcuma and the leaves of ginger; supposed to be a native of the Philippine islands, and probably growing in China, and found by Forster flowering in September, in the island of Tongatabu. 4. The salicifolia, or white willow, S. called in Jamaica the white-bully-tree, or galimeta wood, which supplies good timber. The bark of the sapota and mammosa is very astringent, and is called *cortex jamaicensis*. This was once supposed to be the true Jesuits bark, but its effects on the negroes has been pernicious. These trees cannot be preserved in England, but with great care and much heat.

ACHROMATIC, an epithet expressing a want of colour, introduced into astronomy by De la Lande.

ACHROMATIC *telescopes*, are telescopes contrived to remedy the aberrations in colours. They were invented by Mr. John Dolland, optician. See OPTICS, TELESCOPE.

ACHYRANTHES, in botany, a genus of the Pentandria Monogynia class of plants, belonging to the natural order of Miscellaneæ. There are eleven species, but they have but little beauty, and are only preserved in botanic gardens.

ACHYRONIA, in botany, a genus of the Diadelphia Decandria class and order, calyx five-toothed; the lower tooth elongated and cloven: legume compressed, many-seeded; one species, viz. A. villosa, a shrub found in New Holland, with long silky hairs; leaves lanceolate, acute, entire, with silky hair round the margin.

ACIA, in botany, a genus of the Monadelphia Dodecandria class and order: calyx five-parted, five petals, drupe dry, coriaceous, fibrous, one-seeded. Two species, trees sixty feet high, found in Guiana.

ACICARPHA, in botany, a genus of the Poligamia Necessaria class and order: receptacle chaffy, the chaff uniting with the seeds after flowering; seeds naked; florets tubular; calyx five-parted. One species found in Buenos Ayres.

ACID, in chemistry, a term originally synonymous with *sour*, and applied only to bodies distinguished by that taste; but it now comprehends under it all substances possessed of the following properties. Acids, when applied to the tongue, excite the sensation of sour; they change the blue colours of vegetables to a red; they unite with water in almost any proportion; they combine with all the alkalies, and most of the metallic oxides and earths, and form with them those compounds called in chemistry salts. Every acid does not possess all these properties, but they all possess a sufficient number to distinguish them from other substances. See CHEMISTRY.

ACIDIFIABLE *base*, or RADICAL, any substance capable of uniting without decomposition with such a quantity of oxygen as to become possessed of acid properties. Almost all the acids agree with each other in containing oxygen, but they differ in their bases, which determine the species of the acid. Sulphur combined with certain portions of oxygen forms sulphurous or sulphuric acid, according to the quantity of oxygen absorbed.

ACIDOTON, in botany, a genus of the Monoecia Poliandria class and order; it has male and female flowers on the same, or a different tree. There is but one species, viz. A. urens, a native of Jamaica, which grows to the height of eight or nine feet.

ACIPENSER, a genus of fishes of the order Cartilagenei: the characters are, that the head is obtuse, the mouth is under the head, retractile, and without teeth; that the four cerri are below the front, and before the mouth; the aperture of the gills is at the side, the body is elongated and angulated with many series of scuta, or scaly protuberances. These may be ranked among the larger fish; are inhabitants of the sea, but ascend rivers annually; the flesh of all of them is delicious; from the roe is made caviar, and from the sounds and muscular parts is made isinglass; they feed on worms, and other fishes: the females are larger than the males. There are five species: A. sturio, or common sturgeon, inhabits European, Mediterranean, Red, Black, and Caspian seas, and annually ascends rivers in the spring. (See plate I. Ichthyology, fig. 2.) A. schypa, inhabits the Caspian sea, and large lakes of Siberia. A. ruthenus, and A. stellatus, both inhabit the Caspian sea. A. hufo, inhabits the Danube, Wolga, and other Russian rivers, and also the Caspian. The skin of this species is so hard and tough, as to be used for carriage traces. See STURGEON.

ACNIDA, Virginian hemp, in botany a genus of the Pentandria Pentagynia class and order. There is but a single species, viz. A. cannabina, which is a native of Virginia, and some other parts of America; it is seldom cultivated in Europe.

ACONITUM aconite, wolf's-bane, or

monk's-hood, in botany, a genus of plants of the Trigynia order and Polyandria class, and pertaining to the natural order of Multisiliquæ. In the last edition of Linnæus, by Gmelin, this genus comprehends fourteen species; most of the species of aconite have been deemed poisonous. The ancients were so surprised at their pernicious effects, that they were afraid to touch the plants; and hence sprung many superstitious precautions about the manner of gathering them. Theophrastus relates that there was a mode of preparing the aconite in his days, so that it should only destroy at the end of one or two years. But some have questioned whether the aconite of Theophrastus, Dioscorides, Pliny, and other ancient writers, be the same with ours, or should be referred to the genus of Ranunculus. It is confidently affirmed, that the huntsmen on the Alps, who hunt the wolves, and other wild animals, dip their arrows into the juice of these plants, which renders the wounds occasioned by them mortal. A decoction of the roots has been used to kill bugs; and the powder disguised in bread, or some other palatable vehicle, has been employed to destroy rats and mice. The A. napellus, or common monk's-hood, has been long known as one of the most virulent of all vegetable poisons. Linnæus says, that it is fatal to swine and goats, but does no injury to horses, who eat it dry. He also informs us, from the Stockholm Acts, that an ignorant surgeon died in consequence of taking the fresh leaves, which he prescribed to a patient. The effluvia of the herb in full flower have produced swooning fits, and a temporary loss of sight. The leaves and shoots of this plant, used as salad, instead of celery, have proved fatal in several instances. But the most powerful part of the plant is the root. Matthiolus relates, that it was given by way of experiment to four condemned criminals, two at Rome in 1524, and two at Prague in 1561, two of whom soon died, and the other two, with great difficulty, were recovered. The juice applied to the wound of a finger, not only produced pain in the arm and hand, but cardialgia, anxiety, sense of suffocation, syncope, &c. and the wounded part sphacelated before it came to suppuration. Dodonæus says, that five persons at Antwerp died in consequence of eating it by mistake. The effects of this plant are convulsions, giddiness, insanity, violent evacuations, both upwards and downwards, faintings, cold sweat, and even death itself. Nevertheless it has been used for medicinal purposes. The Indians are said to use aconite, corrected in cow's urine, with good success against fevers. There is one species of it which has been deemed an antidote to those that are poisonous, called anthora, and those that are poisonous are called thora. The taste of the root of the species denominated anthora, is sweet, with a mixture of bitterness and acrimony, and the smell is pleasant. It purges violently when fresh, but loses its qualities when dried. This is poisonous as well as the others, though in a slighter degree, and is disused in the present practice. The first person who ventured to introduce the common monk's-hood into medicine was Dr. Stoerck. Stoerck recommends two grains of the extract to be rubbed into a powder, with two drams of sugar, and to begin with ten grains of this powder two or three times a-day. The extract is often given from one grain to ten for a dose; and some have considerably increased the quantity. Instead of the extract, a tincture has been made of the dried leaves, macerated in six times their weight of spirits of wine, and forty drops given for a dose.

ACORN, an ornamental piece of wood, in the shape of a cone, fixed to the top of the spindle of a mast-head, above the vane, to keep it from coming off the spindle.

ACORUS, in botany, the sweet flag, or sweet rush, a genus of the Monogynia order, and Hexandria class of plants, and belonging to the natural order of Piperitæ. There are two species, viz. the A. calamus, or common sweet rush, of which there are two varieties, the vulgaris, or European sweet rush, or calamus aromaticus, and the Asiaticus or Indian calamus aromaticus. The common calamus aromaticus grows naturally on the banks of the rivers, and in shallow standing waters; and is found in many parts of England, but is much more plentiful in the standing waters of Holland, and is common in many other parts of Europe. The Indian calamus, which grows not only in marsh ditches, but in more elevated and dry places, in Malabar, Ceylon, Amboyna, and other parts of the East Indies, differs but little from the European, except that it is more tender and narrow, and of a more hot and pungent taste; and A. gramineus, or Chinese sweet-grass, has the roots in tufts, with a few thready fibres. The whole herb has an aromatic smell when bruised, resembling the English sweet-flag, from which it is distinguished by the short-

ness of that portion of its stalk, which is above the spadix, as well as by all its parts, except the florets, being five times smaller than in that plant. It is probably a native of China, and cultivated for the sake of its smell, in pots near the habitations of the Chinese. The sweet flag will succeed very well in moist garden ground, but never produces its spikes, unless it grows in water. The dried roots of the calamus aromaticus are commonly imported from the Levant, though those grown in England are equally good. They have a strong aromatic smell, and a warm pungent taste; the flavour is much improved by drying. The powdered root might perhaps supply the place of foreign spices; and indeed it is the only native aromatic plant of northern climates. It is carminative and stomachic, and often used as an ingredient in bitter infusions.

ACOTYLEDONES, in botany, plants so called, because their seeds are not furnished with lobes, and of course put forth no seminal leaves. All mosses are of this kind. See Cotyledones.

ACOUSTICS, in physics, is that science which instructs us in the nature of sound. It is divided by some writers into diacoustics, which explains the properties of those sounds that come distinctly from the sonorous body to the ear; and catacoustics, which treats of reflected sounds: but this distinction is not necessary. In the infancy of philosophy, sound was held to be a separate existence; it was conceived to be wafted through the air to our organs of hearing, which it was supposed to affect in a manner resembling that in which our nostrils are affected when they give us the sensation of smell. Yet, even in those early years of science, there were some, and, in particular, the celebrated founder of the Stoic school, who held that sound, that is, the cause of sound, was only the particular motion of external gross matter, propagated to the ear, and there producing that agitation of the organ by which the soul is immediately affected with the sensation of sound. Zeno says, "Hearing is produced by the air which intervenes between the thing sounding and the ear. The air is agitated in a spherical form, and moves off in waves, and falls on the ear, in the same manner as water undulates in circles when a stone has been thrown into it." The ancients were not remarkable for precision, either of conception or argument, in their discussions, and they were contented with a general and vague view of things. Some followed the opinion of Zeno, without any farther attempts to give a distinct conception of the explanation, or to compare it with experiment. But in later times, during the ardent researches into the phenomena of nature, this became an interesting subject of inquiry. The invention of the air-pump gave the first opportunity of deciding by experiment, whether the elastic undulations of air were the causes of sound; and the trial fully established the point; for a bell rung in vacuo gave no sound, and one rung in condensed air gave a very loud one. It was therefore received as a doctrine in general physics that air was the vehicle of sound. The celebrated Galileo, the parent of mathematical philosophy, discovered the nature of that connection between the lengths of musical chords and the notes which they produced, which had been observed by Pythagoras, or learned by him in his travels in the East, and which he made the foundation of a refined and beautiful science, the theory of music. Galileo shewed, that the real connection subsisted between the tones and the vibrations of these chords, and that their different degrees of acuteness corresponded to the different frequency of their vibrations. The very elementary and familiar demonstration which he gave of this connection, did not satisfy the curious mathematicians of that inquisitive age; and the mechanical theory of musical chords was prosecuted to a great degree of refinement. In the course of this investigation, it appeared that the chord vibrated in a manner precisely similar to a pendulum vibrating in a cycloid. It must therefore agitate the air contiguous to it in the same manner: and thus there is a particular kind of agitation that the air can receive and maintain, which is very interesting.

Sir Isaac Newton took up this question as worthy of his notice; and endeavoured to ascertain with mathematical precision the mechanism of this particular class of undulations, and gave us the principal theorems concerning the undulations of elastic fluids, which make the 47, &c. Propositions of Book II. of his Principles of Natural Philosophy. They have been considered as giving the doctrines concerning the propagation of sound. Most sounds, we all know, are conveyed to us by means of the air. In whatever manner they either float upon it, or are propelled forward in it, certain it is, that, without the vehicle of this or some other fluid, we should have no

sounds at all. Let the air be exhausted from a receiver, and a bell will emit no sound, for, as the air continues to grow less dense, the sound dies away in proportion, so that at last its strongest vibrations are almost totally silent. Thus air is a vehicle for sound. However, we must not, with some philosophers, assert, that it is the only vehicle; that, if there were no air, we should have no sounds whatsoever: for it is found by experiment, that sounds are conveyed through water with the same facility with which they move through air. A bell rung in water returns a tone as distinct, as if rung in air. This was observed by Dr. Derham, who also remarked, that the tone came a quarter deeper. It appears from the experiments of naturalists, that fishes have a strong perception of sounds, even at the bottom of deep rivers. From hence it would seem not to be very material in the propagation of sounds, whether the fluid which conveys them be elastic or otherwise. Water, which, of all substances that we know, has the least elasticity, yet serves to carry them forward; and if we make allowance for the difference of its density, perhaps the sounds move in it with a proportional rapidity to what they are found to do in the elastic fluid of air. But though air and water are both vehicles of sound, yet neither of them, according to some philosophers, seems to be so by itself, but only as it contains an exceedingly subtle fluid, capable of penetrating the most solid bodies. One thing, however, is certain, that whatever sound we hear is produced by a stroke, which the sounding body makes against the fluid, whether air or water. The fluid being struck upon, carries the impression forward to the ear, and there produces its sensation. Philosophers are so far agreed, that they all allow that sound is nothing more than the impression made by an elastic body upon the air or water, and this impression carried along by either fluid to the organ of hearing. But the manner in which this conveyance is made, is still disputed: whether the sound is diffused into the air, in circle beyond circle, like the waves of water when we disturb the smoothness of its surface by dropping in a stone; or whether it travels along, like rays diffused from a centre, somewhat in the swift manner that electricity runs along a rod of iron; these are the questions which have divided the learned. Newton was of the first opinion. He has explained the progression of sound by an undulatory, or rather a vermicular motion in the parts of the air. If we have an exact idea of the crawling of some insects, we shall have a tolerable notion of the progression of sound upon this hypothesis. The insect, for instance, in its motion, first carries its contractions from the hinder part, in order to throw its fore-part to the proper distance, then it carries its contractions from the fore part to the hinder to bring that forward. Something similar to this is the motion of the air when struck upon by a sounding body. All who have remarked the tone of a bell, while its sounds are decaying away, must have an idea of the pulses of sound, which, according to Newton, are formed by the air's alternate progression and recession. And it must be observed, that as each of these pulses is formed by a single vibration of the string, they must be equal to each other; for the vibrations of the string are known to be so. Again, as to the velocity with which sounds travel, this Newton determines, by the most difficult calculation that can be imagined, to be in proportion to the thickness of the parts of the air, and the distance of these parts from each other. From hence he goes on to prove, that each little part moves backward and forward like a pendulum; and from thence he proceeds to demonstrate, that if the atmosphere were of the same density every where as at the surface of the earth, in such a case, a pendulum, that reached from its highest surface down to the surface of the earth, would by its vibrations discover to us the proportion of the velocity with which sounds travel. The velocity with which each pulse would move, he shows, would be as much greater than the velocity of such a pendulum swinging with one complete vibration, as the circumference of a circle is greater than the diameter. From hence he calculates, that the motion of sound will be 979 feet in one second. But this not being consonant to experience, he takes in another consideration, which destroys entirely the rigour of his former demonstration, namely, vapours in the air, and then finds the motion of sound to be 1142 feet in one second, or near 13 miles in a minute, a proportion which experience had established nearly before. Many other theories on this subject have been advanced by ingenious men, but our limits do not allow to enter farther into them.

Since by experiments it has been proved, that sound travels at about the rate of 1142

feet in a second, and that no obstacles hinder its progress, a contrary wind only a small matter diminishing its velocity; the method of calculating its progress is easily made known. When a gun is discharged at a distance, we see the fire long before we hear the sound. If then we know the distance of the place, and know the time of the interval between our first seeing the fire and hearing the report, this will shew us exactly the time that the sound has been travelling to us. For instance, if the gun is discharged a mile off, the moment the flash is seen, you take a watch and count the seconds till you hear the sound; the number of seconds is the time the sound has been travelling a mile. We are also enabled to find the distance between objects that would be otherwise immeasurable. For example, suppose you see the flash of a gun in the night at sea, and tell seven seconds before you hear the report, it follows therefore that the distance is seven times 1142 feet. In like manner, if you observe the number of seconds between the lightning and the report of the thunder, you know the distance of the cloud from whence it proceeds. But according to another philosopher, Dr. Thomas Young, the velocity of sound is not quite so great. "It has been demonstrated," he observes, "by M. De La Grange and others, that any impression whatever communicated to one particle of an elastic fluid, will be transmitted through that fluid with an uniform velocity, depending on the constitution of the fluid, without reference to any supposed laws of the continuation of that impression. Their theorem for ascertaining this velocity is the same as Newton has deduced from the hypothesis of a particular law of continuation: but it must be confessed, that the result differs somewhat too widely from experiment, to give us full confidence in the perfection of the theory. Corrected by the experiments of various observers, the velocity of any impression transmitted by the common air, may, at an average, be reckoned 1130 feet in a second." Phil. Trans. vol. XC.

Dr. Derham has proved by experiment, that all sounds whatever travel at the same rate. The sound of a gun, and the striking of a hammer, are equally swift in their motions; the softest whisper flies as swiftly, as far as it goes, as the loudest thunder. To these we may add, that smooth and clear sounds proceed from bodies that are homogeneous, and of an uniform figure; and harsh or obtuse sounds, from such as are of a mixed matter and irregular figure. The velocity of sounds is to that of a brisk wind as fifty to one. The strength of sounds is greatest in cold and dense air, and least in that which is warm and rarefied. Every point against which the pulses of sound strike, becomes a centre from which a new series of pulses are propagated in every direction. Sound describes equal spaces in equal times.

There is probably no substance which is not in some measure a conductor of sound; but sound is much enfeebled by passing from one medium to another. If a man stopping one of his ears with his finger, stops the other also by pressing it against the end of a long stick, and a watch be applied to the opposite end of the stick, or of a piece of timber, be it ever so long, the beating of the watch will be distinctly heard; whereas, in the usual way, it can scarcely be heard at the distance of 15 or 18 feet. The same effect will take place if he stops both his ears with his hands, and rests his teeth, his temple, or the cartilaginous part of one of his ears against the end of the stick. Instead of a watch, a gentle scratch may be made at one end of a pole or rod, and the person who keeps the ear in close contact with the other end of the pole, will hear it very plainly. Thus, persons who are dull of hearing, may, by applying their teeth to some part of an harpsichord, or other sounding body, hear the sound much better than otherwise.

If a person tie a poker or any other piece of metal on to the middle of a strip of flannel about a yard long, then press with his thumbs or fingers the ends of the flannel into his ears, while he swings the poker against any obstacle, as an iron or steel fender, he will hear a sound very like that of a large church bell.

Sound, like light, after it has been reflected from several places, may be collected in one point, as into a focus; and it will be there more audible than in any other part, even than at the place from whence it proceeded. On this principle it is that a whispering gallery is constructed. The form of a whispering gallery must be that of a concave hemisphere, as ABC, plate Acoustics, fig. 2.; and if a low sound or whisper be uttered at A, the vibrations expanding themselves every way will impinge on the points D, D, D, &c. and from thence be reflected to E, E, E, and from thence to the points F and G, till at last they all meet in C, where the

sound will be the most distinctly heard. The augmentation of sound, by means of speaking-trumpets, is usually illustrated in the following manner: Let ABC, fig. 3, be the tube, BD the axis, and B the mouth-piece for conveying the voice to the tube. Then it is evident when a person speaks at B in the trumpet, the whole force of his voice is spent upon the air contained in the tube, which will be agitated through its whole length, and, by various reflections from the side of the tube to the axis, the air along the middle part of the tube will be greatly condensed, and its momentum proportionably increased, so that when it comes to agitate the air at the orifice of the tube AC, its force will be as much greater than what it would have been without the tube, as the surface of a sphere, whose radius is equal to the length of the tube, is greater than the surface of the segment of such a sphere whose base is the orifice of the tube. For a person speaking at B, without the tube, will have the force of his voice spent in exciting concentric superficies of air all round the point B; and when those superficies or pulses of air are diffused as far as D every way, it is plain the force of the voice will there be diffused through the whole superficies of a sphere whose radius is BD; but in the trumpet it will be so confined, that at its exit it will be diffused through so much of that spherical surface of air as corresponds to the orifice of the tube. But since the force is given, its intensity will be always inversely as the number of particles it has to move; and therefore in the tube it will be to that without, as the superficies of such a sphere to the area of the large end of the tube nearly. But it is obvious, Dr. M. Young observes, that the confinement of the voice can have little effect in increasing the strength of the sound, as this strength depends on the velocity with which the particles move. Were this reasoning conclusive, the voice should issue through the smallest possible orifice; cylindrical tubes would be preferable to any that increased in diameter; and the less the diameter, the greater would be the effect of the instrument; because the plate or mass of air to be moved would, in that case, be less, and consequently the effect of the voice the greater; all which is contradicted by experience. The cause of the increase of sound in these tubes must therefore be derived from some other principles: and among these we shall probably find, that what the ingenious Kircher has suggested is the most deserving of our attention. He tells us, that "the augmentation of the sound depends on its reflection from the tremulous sides of the tube; which reflections, conspiring in propagating the pulses in the same direction, must increase its intensity." Newton also seems to have considered this as the principal cause, in the scholium of Prop. 50, B. II. Princip. when he says, "We hence see why sounds are so much increased in stentorophonic tubes, for every reciprocal motion is, in each return, increased by the generating cause." Farther, when we speak in the open air, the effect on the tympanum of a distant auditor is produced merely by a single pulse. But when we use a tube, all the pulses propagated from the mouth, except those in the direction of the axis, strike against the sides of the tube, and every point of impulse becoming a new centre, from whence the pulses are propagated in all directions, a pulse will arrive at the ear from each of those points. Thus, by the use of a tube, a greater number of pulses are propagated to the ear, and consequently the sound increased. The confinement too of the voice may have a little effect, though not such as is ascribed to it by some; for the condensed pulses produced by the naked voice freely expand every way; but in tubes, the lateral expansion being diminished, the direct expansion will be increased, and consequently the velocity of the particles, and the intensity of the sound. The substance also of the tube has its effect; for it is found by experiment, that the more elastic the substance of the tube, and consequently the more susceptible it is of these tremulous motions, the stronger is the sound. If the tube be laid on any non-elastic substance, it deadens the sound, because it prevents the vibratory motion of the parts. The sound is increased in speaking-trumpets, if the tube be suspended in the air; because the agitations are then carried on without interruption. These tubes should increase in diameter from the mouth-piece, because the parts vibrating in directions perpendicular to the surface will conspire in impelling forward the particles of air, and consequently, by increasing their velocity, will increase the intensity of the sound: and the surface also increasing, the number of points of impulse and of new propagation will increase proportionally. The several causes, therefore, of the increase of sound in these tubes, Dr. Young concludes to be, 1. The diminution of the lateral, and consequently

the increase of the direct expansion and velocity of the included air. 2. The increase of the number of pulses, by increasing the points of new propagation. 3. The reflections of the pulses from the tremulous sides of the tube, which impel the particles of air forward, and thus increase their velocity.

An umbrella, held in a proper position over the head, may serve to collect the force of a distant sound by reflection, in the manner of a hearing-trumpet; but its substance is too slight to reflect any sound perfectly, unless the sound fall on it in a very oblique direction. The exhibition of the Invisible Girl is said to depend on the reflection of sound; but the deception is really performed by conveying the sound through pipes artfully concealed, and opening opposite to the mouth of the trumpet, from which it seems to proceed.

When a portion of a pulse of a sound is separated by any means from the rest of the spherical or hemispherical surface to which it belongs, and proceeds through a wide space, without being supported on either side, there is a certain degree of divergence, by means of which it sometimes becomes audible in every part of the medium transmitting it; but the sound thus diverging is comparatively very faint. Hence, in order that a speaking-trumpet may produce its full effect, it must be directed in a right line towards the hearer; and the sound collected into the focus of a concave mirror is far more powerful than at a little distance from it, which could not happen, if sound, in all cases, tended to spread equally in all directions. It is said that the report of a cannon appears many times louder to a person towards whom it is fired, than to one placed in a contrary direction. It must, says Dr. Young, have occurred to every one's observation, that a sound, such as that of a mill, or a fall of water, has appeared much louder after turning a corner, when the house or other obstacle no longer intervened. Indeed the whole theory of the speaking-trumpet would fall to the ground, if it were demonstrable that sound spreads equally in all directions. In windy weather it may be often observed, that the sound of a distant bell varies almost instantaneously in its strength, so as to appear twice as remote at one time as another. Now if sound diverged equally in all directions, the variation produced by the wind would not exceed one tenth of the apparent distance; but on the supposition of a motion nearly rectilinear, it may easily happen that a slight change in the direction of the wind shall convey a sound, either directly or after reflection, in very different degrees to the same spot.

The decay of sound is the natural consequence of its distribution throughout a larger and larger quantity of matter, as it proceeds to diverge every way from its centre. The actual velocity of the particles of the medium transmitting it appears to diminish simply in the same proportion as the distance from the centre increases: consequently their energy, which is to be considered as the measure of the strength of sound, must vary as the square of the distance; so that at the distance of ten feet from the sounding body the velocity of the particles of the medium becomes one-tenth as great as at the distance of one foot, and their energy, or the strength of the sound, only one-hundredth as great.

An echo is a reflection of sound striking against some object, as an image is reflected in a glass: but it has been disputed what are the proper qualities in a body for thus reflecting sounds. It is in general known, that caverns, grottoes, mountains, and ruined buildings, return this reflection of sound. We have heard of a very extraordinary echo, at a ruined fortress near Louvain, in Flanders. If a person sung, he only heard his own voice, without any repetition; on the contrary, those who stood at some distance, heard the echo, but not the voice; but then they heard it with surprising variations, sometimes louder, sometimes softer, now more near, then more distant. There is an account in the Memoirs of the French Academy, of a similar echo near Rouen. It has been already observed, that every point against which the pulses of sound strike, becomes the centre of a new series of pulses, and sound describes equal distances in equal times; therefore, when any sound is propagated from a centre, and its pulses strike against a variety of obstacles, if the sum of the right lines drawn from that point to each of the obstacles, and from each obstacle to a second point, be equal, then will the latter be a point in which an echo will be heard. Thus let A, fig. 4, be the point from which the sound is propagated in all directions, and let the pulses strike against the obstacles C, D, E, F, G, H, I, &c. each of these points becomes a new centre of pulses by the first principles, and therefore from each of them one series of pulses will pass

through the point B. Now if the several sums of the right lines $\overline{AC+CB}$, $\overline{AD+DB}$, $\overline{AE+EB}$, $\overline{AG+GB}$, $\overline{AH+HB}$, $\overline{AI+IB}$, &c., be all equal to each other, it is obvious that the pulses propagated from A to these points, and again, from these points to B, will all arrive at B at the same instant, according to the second principle; and, therefore, if the hearer be in that point, his ear will at the same instant be struck by all these pulses. Now it appears from experiment, that the ear of an exercised musician can alone distinguish such sounds as follow one another at the rate of 9 or 10 in a second, or any slower rate: and therefore, for a distinct perception of the direct and reflected sound, there should intervene the interval of $\frac{1}{9}$th of a second; but in this time sound describes $\frac{1142}{9}$, or 127 feet nearly. And therefore, unless the sum of the lines drawn from each of the obstacles to the points A and B exceeds the interval AB by 127 feet, no echo will be heard at B. Since the several sums of the lines drawn from the obstacles to the points A and B are of the same magnitude, it appears that the curve passing through all the points, C, D, E, F, G, H, I, &c. will be an ellipse. Hence all the points of the obstacles which produce an echo, must lie in the surface of the oblong spheroid, generated by the revolution of this ellipse round its major axis. See CONIC SECTIONS. As there may be several spheroids of different magnitudes, so there may be several different echoes of the same original sound. And as there may happen to be a greater number of reflecting points in the surface of an exterior spheroid than in that of an interior, a second or a third echo may be much more powerful than the first, provided that the superior number of reflecting points, that is, the superior number of reflecting pulses propagated to the ear, be more than sufficient to compensate for the decay of sound which arises from its being propagated through a greater space. This is finely illustrated in the celebrated echoes at the lake of Killarny, in Kerry, where the first return of the sound is much inferior in strength to those which immediately succeed it. From what has been laid down it appears, that, for the most powerful echo, the sounding body should be in one focus of the ellipse, which is the section of the echoing spheroid, and the hearer in the other. However, an echo may be heard in other situations, though not so favourably; as such a number of reflected pulses may arrive at the same time at the ear as may be sufficient to excite a distinct perception. Thus a person often hears the echo of his own voice; but for this purpose he should stand at least 63 or 64 feet from the reflecting obstacle, according to what has been said before.

If a bell, *a*, fig. 5, be struck, and the undulations of the air strike the wall *cd* in a perpendicular direction, they will be reflected back in the same line; and if a person be situated between *a* and *c*, as at *x*, he would hear the sound of the bell by means of the undulations as they went to the wall, and he would hear it again as they came back, after the reflection, which would be the echo of the sound. So a person standing at *x* might, in speaking in the direction of the wall *cd*, hear the echo of his own voice. But in both cases the distance *cx* must be 63 or 64 feet. If the undulations strike against the wall obliquely, they will be reflected off obliquely on the other side; if, for instance, a person stand at *m*, and there be any obstacle between that place and the bell, so as to prevent him hearing the direct sound, he may nevertheless hear the echo from the wall *cd*, provided the direct sound fall in that sort of oblique direction so as to force the reflected undulations along the line *cm*.

At the common rate of speaking, we do not pronounce above three syllables and a half, that is, seven half syllables in a second; therefore, that the echo may return just as soon as three syllables are expressed, twice the distance of the speaker from the reflecting object must be equal to 1000 feet; for as sound describes 1142 feet in a second, $\frac{6}{7}$ths of that space, that is 1000 feet nearly, will be described while six half, or three whole, syllables are pronounced; that is, the speaker must stand near 500 feet from the obstacle. And, in general, the distance of the speaker from the echoing surface, for any number of syllables, must be equal to the seventh part of the product of 1142 feet multiplied by that number. In churches we never hear a distinct echo of the voice, but a confused sound, when the speaker utters his words too rapidly; because the greatest difference of distance between the direct and reflected courses of such a number of pulses as would produce a distinct sound is never in any church equal to 127 feet, the limit of echoes. But though the first reflected pulses may produce no echo, both on account of their being too few in

number, and too rapid in their return to the ear; yet it is evident, that the reflecting surface may be so formed, as that the pulses which come to the ear after two reflections or more, may, after having described 127 feet or more, arrive at the ear in sufficient numbers, and also so nearly at the same instant, as to produce an echo, though the distance of the reflecting surface from the ear be less than the limit of echoes. This is confirmed by a singular echo in a grotto on the banks of the little brook called the Dinan, about two miles from Castlecomber, in the county of Kilkenny. As you enter the cave, and continue speaking loud, no return of the voice is perceived; but on your arriving at a certain point, which is not above 14 or 15 feet from the reflecting surface, a very distinct echo is heard. Now this echo cannot arise from the first course of pulses that are reflected to the ear, because the breadth of the cave is so small, that they would return too quickly to produce a distinct sensation from that of the original sound: it therefore is produced by those pulses, which, after having been reflected several times from one side of the grotto to the other, and having run over a greater space than 127 feet, arrived at the ear in considerable numbers, and not more distant from each other in point of time than the ninth part of a second. M. De la Grange demonstrated that all impressions are reflected by an obstacle terminating an elastic fluid with the same velocity with which they arrived at that obstacle. When the walls of a passage, or of an unfurnished room, are smooth and perfectly parallel, any explosion, or a stamping with the foot, communicates an impression to the air, which is reflected from one wall to the other, and from the second again towards the ear, nearly in the same direction, with the primitive impulse; this takes place as frequently in a second, as double the breadth of the passage is contained in 1130 feet; and the ear receives a perception of a musical sound, thus determined its pitch by the breadth of the passage. On making the experiment, the result will be found accurately to agree with this explanation. If the sound is predetermined, and the frequency of vibrations such as that each pulse, when doubly reflected, may coincide with the subsequent impulse, proceeding directly from the sounding body, the intensity of the sound will be much increased by the reflection; and also, in a less degree, if the reflected pulse coincides with the next but one, the next but two, or more of the direct pulses. The appropriate notes of a room may readily be discovered by singing the scale in it; and they will be found to depend on the proportion of its length or breath to 1130 feet.

By altering our situation in a room, and expressing a sound, or hearing the sound of another person, in different situations, or when different objects are alternately placed in the room, that sound may be heard louder or weaker, and more or less distinct. Hence it is, that blind persons, who are under the necessity of paying great attention to the perceptions of their sense of hearing, acquire the habit of distinguishing from the sound even of their own voices, whether a room is empty or furnished; whether the windows are open or shut, and sometimes they can even distinguish whether any person be in the room or not. A great deal of furniture in a room checks, in a great measure, the sounds that are produced in it, for they hinder the free communication of the vibrations of the air from one part of the room to the other. The fittest rooms for declamation, or for music, are such as contain few ornaments that obstruct the sound, and at the same time have the least echo possible.

A strong and continued sound fatigues the ear. The strokes of heavy hammers, of artillery, &c. are apt to make people deaf for a time: and it has been known that persons who have been long exposed to the continued and confused noise of certain manufactories, or of water-falls, or other noisy places, can hear what is spoken to them much better in the midst of that noise than elsewhere.

We shall conclude this article with an experiment or two for the amusement of the younger part of our readers.

Experiment 1. Place a concave mirror, AB, fig. 6, of two feet in diameter, in a perpendicular direction, and at the distance of about five or six feet from a partition EF, in which there is an opening equal in size to the mirror; against this opening must be placed a picture painted in water-colours, on a thin cloth, that the sound may easily pass through it. Behind the partition, at the distance of a few feet, place another mirror GH, of the same size as the former, and directly opposite to it. At the point C is to be placed the figure of a man seated on a pedestal, with his ear exactly in the focus of the first mirror; his lower jaw must be made to open by a

wire, and shut by a spring. The wire must pass through the figure, and under the floor, to come up behind the partition. Let a person properly instructed be placed behind the partition, near the mirror; any one may now whisper into the ear of the image, with the assurance of being answered. The deception is managed by giving a signal to the person behind the partition, who by placing his ear to the focus I, of the mirror GH, will hear distinctly what the other said, and moving the jaw of the statue by the concealed wire, will return the answer directly, which will be heard distinctly by the first speaker.

Ex. 2. Let two heads of plaster of Paris be placed on pedestals, on opposite sides of a room. A tin tube of an inch in diameter must pass from the ear of one head through the pedestal under the floor, and go up to the mouth of the other. When a person speaks low into the ear of one bust, the sound is reverberated through the length of the tube, and will be distinctly heard by any one who shall place his ear to the mouth of the other. The end of the tube which is next the ear of the one head should be considerably larger than that end which comes to the mouth of the other. If there be two tubes, one going to the ear, and the other to the mouth of each head, two persons may converse together, by applying their mouth and ear reciprocally to the mouth and ear of the busts, while other people standing in the middle of the room, between the heads, will not hear any part of the conversation.

Ex. 3. Fig. 7 is a representation of the Eolian harp, which was probably invented by Kircher. This instrument may be made by almost any carpenter; it consists of a long narrow box of very thin deal, about five or six inches broad, and two inches deep, with a circle in the middle of the upper side of an inch and a half in diameter, in which is drilled small holes. On this side seven, ten, or more strings of very fine gut are stretched over bridges at each end, like the bridge of a fiddle, and screwed up or relaxed with screw-pins. The strings are all tuned to one and the same note; and the instrument is placed in some current of air, where the wind can pass over its strings with freedom. A window, of which the width is exactly equal to the length of the harp, with the sash just raised to give the air admission, is a proper situation. When the air blows upon these strings with different degrees of force, it will excite different tones of sound; sometimes the blast brings out all the tones in full concert, and sometimes it sinks them to the softest murmurs.

There are different kinds of these instruments; one, invented by the Rev. W. Jones, has the strings fixed to a sounding-board, or belly, within a wooden case, and the wind is admitted to them through an horizontal aperture. In this form the instrument is portable, and may be used any where in the open air. The tension of the strings must not be great, as the air, if gentle, has not sufficient power to make them vibrate, and if it blows fresh, the instrument does not sing, but scream. See HARMONICS.

ACQUITTAL, in law, is a deliverance or setting free from the suspicion of guilt; as one who is discharged of a felony is said to be acquitted thereof.

Acquittal is either in fact, or in law; in fact, it is where a person, on a verdict of the jury, is found not guilty; in law, it is when two persons are indicted, one as a principal, &c. the other as accessary: here if the former be discharged, the latter of consequence is acquitted.

ACQUITTANCE, a discharge in writing for a sum of money, witnessing that the party is paid the same.

A man is obliged to give an acquittance on receiving money: and a servant's acquittance for money received for the use of his master shall bind him, provided the servant used to receive his master's rents. An acquittance is a full discharge, and bars all actions, &c.

ACRIDÆ, in entomology, the name by which Linnæus has distinguished the first family of the gryllus, or the cricket, properly so called: the characters of which are, that the head is conical and longer than the thorax, and the antennæ ensiform, or sword-shaped. Of this family there are eight species, none of which are found in Britain. The insects of this family feed on other insects. See GRYLLUS.

ACROCHORDUS, in natural history, a genus of the class Amphibia, and of the order Serpents. There are but three species, viz. A. javanicus, warted snake, brown, beneath paler; the sides obscurely variegated with whitish. It inhabits Java, chiefly among the pepper plantations; grows sometimes to seven feet long. The warts, by means of a magnifying glass, appear to be convex carinate scales, and the smaller ones are furnished with two smaller prominences, one each side the larger. Head somewhat flattened, hardly wider than the neck, body gradually thicker towards the middle,

Fig. 1.

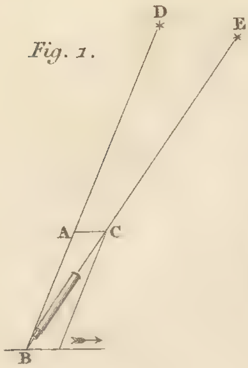


Fig. 2.

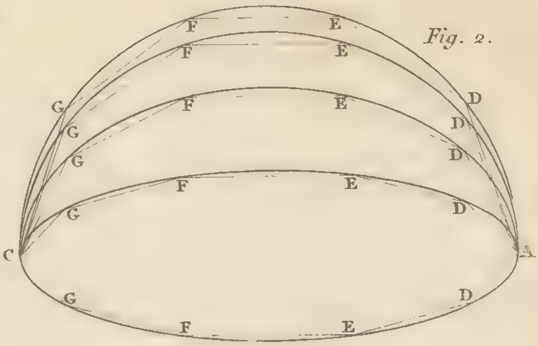


Fig. 3.

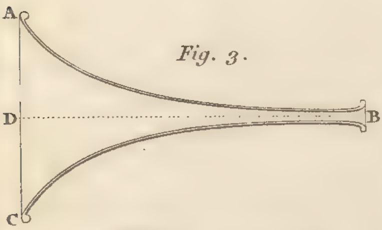


Fig. 4.

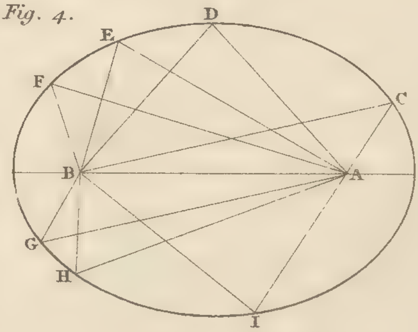


Fig. 5.

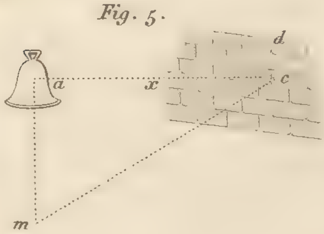


Fig. 7.

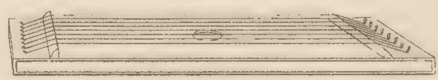
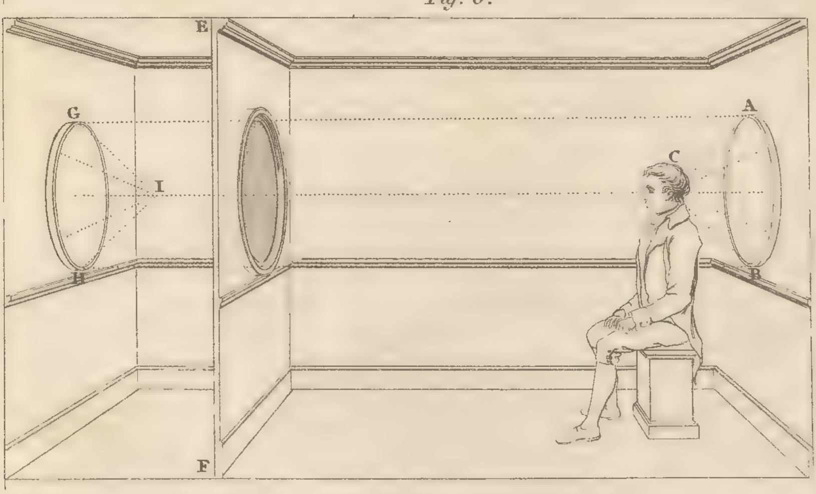


Fig. 6.



Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, Feb.y 1808.

and suddenly contracting near the tail, which is short and slightly acuminate. A. dubius, which very nearly resembles the javanicus, except that the head is covered with very minute, rough, and warted scales, differing in size alone from those on the other part of the animal. The dubius measures only about three feet in length. A specimen is to be seen in the British Museum. Its native place is not ascertained. A. fasciatus, resembles the dubius so much, that some naturalists suppose them both to be of the same species, and differing only in age and cast of colours. The specimen in the British Museum is about eighteen inches long. See plate Serpentes, fig. 1.

ACRONICHAL, or ACHRONYCAL, in astronomy, an appellation given to the rising of a star above the horizon, at sunset; or to its setting, when the sun rises. Acronichal is one of the three poetical risings of a star; the other two being called cosmical and helical.

This term is also applied to the superior planets Saturn, Jupiter, and Mars, when they are come to the meridian of midnight.

ACROSTERMUM, in botany, a genus of the Cryptogamia Fungi class and order; fungus quite simple, nearly erect, emitting the seeds exteriorly from the top. There are four species.

ACROSTICUM, *rusty-back, wall-rue*, or *forked-fern*, in botany, a genus of the Cryptogamia Filices; the character of which is, that the fructifications cover the whole inferior surface of the leaf. There are 45 species distributed into different classes. Few of the species have been introduced into gardens. Those of Europe may be preserved in pots, filled with gravel and lime-rubbish, or planted on walls, and artificial rocks; but most of them being natives of very hot climates, must be planted in pots, and plunged into the bark pit.

ACTÆA, in botany, a genus of plants of the Polyandria Monogynia class and order. Gen. character; calyx perianth, four-leaved; leaflets roundish, obtuse, concave, caducous; cor. petals four, accuminate to both ends, larger than the calyx; filaments about 30; germ superior ovate; no stile; stigma thickish, obliquely depressed; pericarp a berry, oval-globose, smooth, one-furrowed, one celled; seeds very many, semi-orbicular, lying over each other in two rows. There are four species, viz. the spicata; racemosa; japonica, and aspera; of the first there are varieties, as the black-berried herb Christopher, or bane-berry, found in the northern parts of England; the Christopher with white berrries, a native of America; and that with red berries. The racemosa, or black snake-root, found also in America, of which the root is much used in many disorders, and is supposed to be an antidote against the bite of the rattle-snake. The leaves of the A. aspera, being extremely rough, the Chinese use them in polishing their tin ware.

ACTINIA, in natural history, a genus of the Mollusca order of worms; the characters of which are, body oblong, cylindrical, fleshy, contractile, fixed by the base; mouth terminal, expansile, surrounded with numerous cirri, and without any aperture. There are 36 species. These marine animals are viviparous, and have no aperture but the mouth. They feed on shell-fish, and other marine animals, which they draw in with their feelers, in a short time rejecting through the same aperture the shells and indigestible parts. They assume various forms; and where the tentacula or feelers are all expanded, have the appearance of full-blown flowers. Many of them are eatable, and some of them very sapid.

ACTINOLITE, in mineralogy, a family, comprehending six species, viz. the actinolite, smaragdite, tremolite, cyanite, saylite, and schalstone. The actinolite occurs chiefly in beds in primitive mountains, and is divided into three sub-species, viz. the asbestos, common, and glassy. The asbestos colours greenish grey, mountain green, smelt blue, olive green, yellowish, and liver-brown, Massive, and in capillary crystals. Soft; brittle; specific gravity 2.5 to 2.9. Melts before the blow-pipe. The usual colour of the common is leek green, but its specific gravity is between 3.0 and 3.3. The principal colour of the glassy is mountain green, passing to the emerald green. Specific gravity 2.9 to 3.9.

ACTION, in mechanics and physics, is the pressure or percussion of one body against another.

It is one of the laws of nature, that action and re-action are equal, that is, the resistance of the body moved is always equal to the force communicated to it; or, which is the same thing, the moving body loses as much of its force, as it communicates to the body moved.

If a body be urged by equal and contrary actions or pressures, it will remain at rest. But if one of these pressures be greater than its opposite, motion will ensue toward the parts least pressed.

It is to be observed, that the actions of bodies on each other, in a space that is carried uniformly forward, are the same as if the space were at rest: and any powers or motions that act upon all bodies, so as to produce equal velocities in them in the same, or in parallel right lines, have no effect on their mutual actions, or relative motions. Thus the motion of bodies aboard a ship, that is carried steadily and uniformly forward, are performed in the same manner as if the ship was at rest. The motion of the earth round its axis has no effect on the actions of bodies and agents at its surface, but so far as it is not uniform and rectilineal. In general, the actions of bodies upon each other depend not on their *absolute*, but *relative* motion.

Action, in law, denotes either the right of demanding, in a legal manner, what is any man's due, or the process brought for the recovering the same.

Actions are either criminal or civil.

Criminal actions are to have judgment of death, as appeals of death, robbery, &c. or only judgment for damage to the injured party, fine to the king, and imprisonment.

Under the head of criminal actions may likewise be ranked penal actions, which lie for some penalty or punishment on the party sued, whether it be corporal or pecuniary.

Also actions upon the statute, brought on breach of any stutute, or act of parliament, by which an action is given that did not lie before; as where a person commits perjury to the prejudice of another, the injured party shall have an action upon the statute. And lastly, popular actions, so called, because any person may bring them on behalf of himself and the crown, by information, &c. for the breach of some penal statute.

Civil actions are divided into real, personal, and mixed.

Real action is that whereby a man claims a title, lands, tenements, &c. in fee, or for life, and this action is either possessory, or ancestral; possessory, where the lands are a person's own possession or seisin; ancestral, when they were of the possession or seisin of his ancestors.

Personal action, is one brought by one man against another, upon any contract for money or goods, or on account of trespass, or other offence committed; and thereby the debt, goods, chattels, &c. claimed.

Mixt action, one lying as well for the thing demanded as against the person who has it; and on which the thing is recovered with damages for the wrong sustained; such is an action of waste, sued against a tenant for life, the place wasted being recoverable, with treble damages for the wrong done.

ACTS *of parliament*, statutes, acts, edicts, made by the king, with the advice and consent of the lords spiritual and temporal, and commons, in parliament assembled. An act of parliament is the highest possible authority, and hath power to bind not only every subject, but the king himself, if particularly named therein, and cannot be altered or repealed but by the same authority. Where the common law and the statute law differ; the common law gives place to the statute, and an old statute gives place to a new one. Penal statutes must be construed strictly; thus a statute of Edw. I. having enacted, that those convicted of stealing horses should not have the benefit of clergy, the judges conceived that this did not extend to him that should steal but one horse, and a new act for that purpose was passsd in the following year. Statutes against frauds are to be liberally and beneficially expounded. One part of a stutute must be construed by another, that the whole may, if possible, stand. A saving clause totally repugnant to the body of the act. If a statute that repeals another is itself repealed afterwards, the first statute is hereby revived. Acts of parliament derogatory from the power of subsequent parliaments bind not. Acts of parliament that are impossible to be performed are of no validity.

ACULEATE, or Aculeated, an appellation given to any thing that has aculei, or prickles: thus fishes are divided into those with aculeated and not aculeated fins.

The same term is applied, in botany, to the stems and branches of those plants that are furnished with prickles, as the rose, the raspberry, and barberry trees. The prickle differs from the thorn, which is another species of armature, or defence, against animals, in being only a prolongation of the cortex or outer bark of the plant, and not connected with nor protruded from the wood. This is apparent from the ease with which such prickles are detached from the stem with the bark, while the other, and more rigid species of weapon, being an expansion of the ligneous body, cannot be detached without rendering and tearing the

substance of the wood. Prickles are either straight, as in the solanum indicum: or bent inwards, as in the mimosa cineraria; or bent outwards; or downy, that is, covered with a sort of wool. See TOMENTUM.

ACUMINATE, in natural history, a term applied to fishes whose tails end in a sharp point.

AD, a Latin preposition, expressing the relation of one thing to another.

It is frequently prefixed to other words: thus,

AD *hominem*, among logicians, an argument drawn from the professed belief or principles of those with whom we argue.

AD *valorem*, among the officers of the king's revenue, a term used for such duties, or customs, as are paid according to the value of the goods sworn to by the owner.

ADAGIO, in music, signifies the second degree of music from slow to quick. It is applied to music not only meant to be performed in slow time, but also with grace and embellishment.

ADAMANTINE *spar*, in mineralogy, one of the species of the ruby family, found only in China. Colour dark hair brown. Massive, crystallized in six-sided prisms, and six-sided pyramids, having their apex truncated. Specific gravity 3.98. See RUBY.

ADAMBEA, in botany, a genus of the Polyandria Monogynia class and order, of which there is but a single species, which grows on the coast of Malabar, in sandy and stony places; rises to about seven feet, and sends forth branches which are terminated by panicles of fine purple flowers, large and resembling roses.

ADANSONIA, in botany, a genus of the Monadelphia order, and Polyandria class, named after Michael Adanson, an indefatigable French naturalist. The A. digitata, Ethiopean sour-gourd, or monkies' bread, called also abavo, is the only species known of this genus.

ADDER. See COLUBER.

ADDITION, in arithmetic, the first of the four fundamental rules of that art, whereby we find a sum equal to several smaller ones. See ALGEBRA and ARITHMETIC.

ADDITIONS, in law, denote all manner of designations given to a man, over and above his proper name and surname, to shew of what estate, degree, mystery, place of abode, &c. he is.

Additions of degree are the same with titles of honour or dignity, as knight, lord, earl, duke, &c.

Additions of estate are yeoman, gentleman, esquire, and the like.

Additions of mystery, or trade, are carpenter, mason, painter, engraver, and the like.

Additions of place, or residence, are London, Edinburgh, Bristol, York, Glasgow, Aberdeen, &c.

These additions were ordained to prevent one man's being grieved, or molested, for another; and that every person might be certainly known, so as to bear his own burden.

If a man is of different degrees, as duke, earl, &c. he shall have the most worthy; and the title of knight, or baronet, is part of the party's name, and therefore ought to be rightly used; whereas that of esquire, or gentleman, being as people please to call them, may be used, or not, or varied at pleasure.

A Peer of Ireland is no addition of honour here; nay, the law-addition to the children of British noblemen is only that of esquire, commonly called lord.

Writs without the proper additions, if excepted to, shall abate; only where the process of outlawry doth not lie, additions are not necessary. The addition of a parish, not in any city, must mention the county, otherwise it is not good.

ADDITION, in heraldry, something added to a coat of arms, as a mark of honour; and therefore directly opposite to abatement.

ADDUCTOR, in anatomy, a general name for all such muscles as serve to draw one part of the body towards another. See ANATOMY.

ADELIA, in botany, a genus of the Dioecia Gynandria class and order. Male: calyx three parted; no corolla; stamina numerous; united at the base. Female: calyx five parted; no corolla; styles three, lacerated. Capsule three-grained.

ADENANTHERA, in botany, a genus of the Decandria Monogynia class of plants, the calyx of which is a single-leaved perianthium, very small, and cut into five segments: the corolla consists of five lanceolated bell-shaped petals; the fruit is a long membranaceous compressed pod, containing several round seeds. There are three species: A. paronina, which is one of the largest trees in the East Indies. Its duration is 200 years, and its timber is much used on account of its solidity: the powder of the leaves is used in their religious ceremonies; the seeds are eaten, and also valued

as weights, being each of them four grains. This species must be raised on a hot-bed from seeds. It has never flowered in England: it is of very slow growth. The other species, viz. the A. falcata, and A. scandens, have not been cultivated in this country.

ADENIA, in botany, a genus of the Hexandria Monogynia class and order, that grows in Arabia. There is but one species, which is mentioned by Forskal, in his Flor. Ægypt. He says that the powder of the young branches mixed in any kind of liquor is a strong poison, and that the capparis spinosa is an antidote to it.

ADFECTED *equations*, in algebra, those wherein the unknown quantity is found in two or more different powers: such is $x^3 - ax^2 + bx = a^2 b$.

ADHESION, in philosophy and chemistry, is a term generally made use of to express the property which certain bodies have of attracting to themselves other bodies, or the force by which they adhere together: thus, water adheres to the finger, mercury to gold, &c. Hence arises an important distinction between two words, that in a loose and popular sense are often confounded. Adhesion denotes an union to a certain point between two dissimilar substances, and cohesion that which retains together the component particles of the same mass. See COHESION.

Adhesion may take place either between two solids, as two hemispheres of glass, which, according to an experiment of Desaguliers, adhere to each other with a force equal to 19 ounces on a surface of contact one-tenth of an inch in diameter; or between solids and fluids, as the suspension of water in capillary tubes; or lastly, between two fluids, as oil and water. About the same time Mr. Hauksbee proved experimentally the error which Bernoulli had fallen into, in attributing the adhesion of surfaces and capillary attraction to the pressure of the atmosphere. Nevertheless, in 1772, M. M. Lagrange and Cigna, taking for granted a natural repulsion between water and oily substances, imagined, if there was an adhesion between water and oil, or tallow, that it must be occasioned by a cause different from attraction: and having ascertained the reality of the adhesion, they concluded that it was occasioned by the pressure of the air, and that Dr. Taylor's method was not well founded.

Such was the state of opinions on the subject, when, in 1773, Guyton Morveau made his celebrated experiments on adhesion, in presence of the Dijon Academy, demonstrating, as indeed Hauksbee had done before him, not only that water ascends between two parallel plates of tallow, separated from each other $\frac{1}{8}$ of a line, but also that the atmospheric pressure is not in the least degree the cause of the phenomenon, which is solely attributable to attraction: in proof of this, a polished disk of glass, 30 lines in diameter, was suspended to the arm of a balance, and brought into contact with a surface of mercury; the counterpoise required to separate it was equivalent to 9 gros and a few grains, and upon moving the apparatus into the receiver of an air-pump, and forming as perfect a vacuum as possible, precisely the same counterpoise was required as before.

In the prosecution of his inquiries on this subject, he observed, that the same disk of glass, which, when in contact with pure water, adhered to it with a force equal to 258 grains, required a counterpoise of only 210, in order to separate it from a solution of potash, notwithstanding the superior density of this last. This inequality of effects on equal diameters, and in an inverse order to that of the respective specific gravities of the two fluids, appeared not only to be decisive in favour of Dr. Taylor's method, but to encourage the hope of applying it to the calculation of chemical affinities.

In order to verify this proposition, plates of the different metals in their highest state of purity were procured, perfectly round, an inch in diameter, of the same thickness, well polished, and furnished with a small ring in the centre of each, so as to keep them suspended precisely parallel to the plane of the horizon. Each of these plates was in turn suspended to the arm of an assay balance, and exactly counterpoised by weights placed in the scale attached to the opposite arm; the plate, thus balanced, was applied to the surface of some mercury in a cup, about two lines beneath it, by sliding the plate over the mercury as in the silvering of mirrors, so as to exclude every bubble of air; weights were then successively added, till the adhesion between the plate and mercury was broken. Fresh mercury was used for each experiment. The following is the table of results:

Gold adheres to mercury with a force equal to	446	grains.
Silver	429	
Tin	418	
Lead	397	
Bismuth	372	

Zinc adheres to mercury with a force equal to	204 grains.
Copper	142
Antimony (regulus)	126
Iron	115
Cobalt	8

The striking differences in the above table shew that the pressure of the atmosphere has no share in them, since in this respect the circumstances of each were precisely similar; nor do they depend on the respective specific gravities; for if so, silver should rank after lead, cobalt before zinc, and iron before tin. The only order which agrees with the above is that of the chemical affinity of these metals, or the respective degrees of their solubility in mercury. It is highly probable, therefore, that at least the principal part of the adhesive force thus found by experiment is owing to chemical affinity; and that the above numerical series 446, 429, 418, 397, &c. is an approximation towards the ratio of the relative affinities of gold, silver, tin, lead, &c. for mercury.

ADIANTHUM, *Maidenhair*, in botany, the name of a genus of plants of the Cryptogamia Filices class and order, the characters of which are, that the fructifications are collected in oval spots at the ends of the leaves, which are folded back. There are forty-four species, of which one only belongs to Great Britain, viz. the A. capillus veneris, which is found rarely in Scotland and Wales, on rocks and moist walls, and which is a native of the south of Europe and the Levant. From this the syrup of capillaire is made.

ADIPOCIRE, is a term formed of adeps, fat, and cera, wax, and denotes a substance, the nature and origin of which are thus explained. The changes which animal matter undergoes in its progress towards total decomposition, have been, for many obvious reasons, but little attended to. But an opportunity of this kind was offered at Paris in 1786 and 1787, when the old burial ground of the Innòcens was laid out for building upon, in consequence of which, the surface soil, and the animal remains contained therein, were removed. This cemetery having been for ages appropriated to the reception of the dead, in one of the most populous districts in Paris, was eminently well calculated to exhibit the various processes of animal decomposition: another favourable circumstance was, that it contained several of those large pits (fosses communes) in which the bodies of the poor are deposited by hundreds. These pits are cavities 30 feet deep, with an area of 20 feet square, in which the shells containing the bodies are closely packed in rows over each other, without any intermediate earth, and with only a slight superficial covering of soil, not more than a foot thick: each pit contained from 1200 to 1500 bodies, and may be considered as a mass of animal matter of the dimensions above-mentioned. M. M. Fourcroy and Thouret were present at the opening of several of these receptacles; and it is from a memoir by the former of these, that the principal part of this article is composed. The first pit that was examined had been filled and closed up 15 years before: on opening some of the coffins (for the wood was still quite sound, only tinged of a yellow colour) the bodies were found within shrunk, so as to leave a considerable vacant space in the upper part of the coffin, and flattened, as if they had been subject to a strong compression; the linen which covered them adhered firmly, and upon being removed, presented to view only irregular masses of a soft, ductile, greyish-white matter, apparently intermediate between fat and wax: the bones were enveloped in this, and were found to be very brittle. The bodies thus changed, being but little offensive to the smell, a great number were dug up and minutely examined: in some this alteration had, as yet, only partially taken place, the remains of muscular fibres being still visible; but where the conversion had been complete, the bones throughout the whole body were found covered with this grey substance, generally soft and ductile, sometimes dry, but always readily separating into porous cavernous fragments, without the slightest trace of muscles, membranes, vessels, tendons, or nerves: the ligaments of the articulations had been in like manner changed; the connexion between the bones was destroyed, and these last had become so yielding, that the grave-diggers, in order to remove the bodies more conveniently, rolled each upon itself from head to heels, without any difficulty. According to the testimony of these men, to whom the facts just mentioned had been long familiar, this conversion of animal matter is never observed in those bodies that are interred singly, but always takes place in the fosses communes: to effect this change, nearly three years are required. The soapy matter of latest formation is soft, very ductile, light, and spungy, and contains water; in 30 or 40 years it becomes much dryer, more brittle, and assumes the appearance of dense laminæ,

and where the surrounding earth has been dryer than usual, it is sometimes semitransparent, of a granulated texture, brittle, and bears a considerable resemblance to wax. Animal matter having once passed into this stage of decomposition, appears to resist for a long time any further alteration: some of these pits that had been closed above 40 years, were, upon examination, found to be little else than a solid mass of soapy matter; nor is it yet ascertained how long in common circumstances it would continue unchanged, the burial ground of the Innòcens being so small in comparison to the population of the district, as to require each pit in 30 or 40 years to be emptied of its contents, in order to receive a new succession of bodies: it appears, however, that the ulterior changes depend in a great measure on the quantity of moisture draining through the mass. From the history of this singular substance, we proceed to an examination of its chemical properties. It was first, however, purified by gently heating in an earthen vessel, till it became of a pasty consistence, and then rubbed through a fine hair sieve, by which means the hair, small bones, and remains of the muscular fibre were separated with tolerable exactness. In this state, being exposed in an earthen vessel to the naked fire, it readily became soft, but did not liquify without considerable difficulty, rather frying as a piece of soap would do, and disengaging at the same time ammoniacal vapours. Four pounds being put into a glass retort, and submitted to slow distillation in a water bath, afforded in the space of three weeks eight ounces of a clear watery fluid, with a fœtid odour, turning syrup of violets green, and manifestly containing ammonia in solution; the soapy matter remaining in the retort had acquired a greater consistence, was become less fusible, of a deeper brown colour, and upon cooling, was evidently drier than before, though not admitting of being broken. Eight ounces of soapy matter, white and purified, were mixed with an equal weight of powdered quick lime; on the addition of a little water, the mass heated, swelled, and disengaged a very strongly ammoniacal vapour, accompanied by a peculiar putrescent smell: a sufficiency of water being then added to bring the whole to the state of an emulsion, it was heated to ebullition, much ammoniacal vapour escaping at the same time; the liquor being thrown on a filter, passed perfectly clear and colourless, and appeared to be only lime-water, with a very small quantity of soap in solution: the matter remaining on the filter, being well washed, was beaten up with water, but showed no tendency to unite with it, subsiding after a time, in the form of a white mass; this by drying for a few days in the open air, became grey and much reduced in volume: it was then mixed with diluted muriatic acid, which immediately decomposed it, and a number of white clots rose to the surface of the liquor. This last being obtained clear by filtration, yielded crystals of muriat of lime and a slight trace of phosphoric salt; the white clots being washed and dried, and afterwards melted in a water bath, cooled into a dry, combustible, oily matter, brittle, waxy, crystallizable, and perfectly insoluble in water, to which the name of adipocire has been appropriated. From this series of experiments with lime, it appears that the soapy matter is a true ammoniacal soap, with a base of adipocire, to which lime has a stronger affinity than ammonia; but which last composition is again in its turn decomposed by all the acids, leaving the adipocire in a state of purity. Potash and soda produce effects perfectly analogous to those of lime. To the foregoing experiments of Fourcroy, a few facts have since been added by Dr. Gibbes. The receptacle at Oxford for those bodies which have been used by the anatomical professor there for his demonstrations, is a hole dug in the ground to the depth of thirteen or fourteen feet, and a little stream is turned through it, in order to remove all offensive smell: the flesh contained in this was found, on examination, to be quite white, and for the most part changed into the soapy matter above mentioned. From this hint, pieces of lean beef were enclosed in a perforated box, and placed in running water, and at the end of a month were found converted into a mass of fatty matter; this change was observed to take place much sooner and more completely in running than in stagnant water: in order to get rid of the fœtid smell, nitrous acid was had recourse to, which immediately had the desired effect; a waxy smell was perceived, and by melting the matter it was obtained nearly pure; the yellow colour, which had been given to it by the nitrous acid, was wholly discharged by the oxymuriatic acid. A similar conversion of muscular fibre takes place by maceration in very diluted nitrous acid. Dr. Gibbes has not mentioned whether the fatty matter produced by running water is pure

adipocire, or ammoniacal soap; it appears probable, however, that it is in the former state; where nitrous acid is the menstruum employed, it is obviously impossible that the adipocire should be combined with an alkali.

ADIT *of a mine*, the hole or aperture whereby it is entered and dug, and by which the water and ores are carried away: it is distinguished from the air-shaft. The adit is usually made on the side of a hill, towards the bottom, about four or six feet high, and eight wide, in form of an arch; sometimes cut into the rock, and sometimes supported with timber, so conducted, as that the sole or bottom of the adit may answer to the bottom of the shaft, only somewhat lower, that the water may have a sufficient current to pass away without the use of the pump.

ADJUTAGE, or AJUTAGE, in hydraulics, the tube fitted to the mouth of a pipe through which a fountain plays. See HYDRAULICS.

ADJUTANT, in the military art, an officer whose business it is to assist the major, and therefore sometimes called the aid major.

ADJUTANT-*general*, an officer of distinction, who assists the general in his laborious duty: he forms the several details of duty of the army, with the brigade majors, and keeps an account of the state of each brigade and regiment. In the day of battle he sees the infantry drawn up, after which he places himself by the side of the general to receive orders. In a siege he visits the several posts, gives and signs all orders, and has a serjeant from each brigade to carry any orders which he may have to send.

ADMEASUREMENT, in law, a writ for adjusting the shares of something to be divided. Thus, admeasurement of dower takes place, when the widow of the deceased claims more as her dower than what of right belongs to her. And, admeasurement of pasture may be obtained, when any of the persons who have right in a common pasture puts more cattle to feed on it than he ought.

ADMINISTRATOR, in law, the person to whom the goods, effects, or estate of one who died intestate are entrusted; for which he is to be accountable, when required.

The bishop of the diocese where the party dies, is regularly to grant administration; but if the intestate has goods in several dioceses, administration must be granted by the archbishop in the prerogative court. The persons to whom administration is granted are, a husband, wife, children, whether sons or daughters, the father or mother, brother or sister, and, in general, to the next of kin, as uncle, aunt, cousin; then to a creditor.

An action lies for and against an administrator, as for and against an executor; only that he is accountable no farther, than to the value of the goods.

ADMIRAL, in maritime affairs, a great officer, who commands the naval forces of a kingdom or state, and decides all maritime causes. For the latter purposes a commission has been instituted in England, who, by a statute of W. and M. have the same authority as the Lord High Admiral. The admirals of England are merely naval commanders. Every other business relative to the navy at large is directed by the Lords Commissioners of the Admiralty. See PRECEDENCE, ADMIRALTY COURT, &c.

ADMIRALTY, properly signifies the office of Lord High Admiral, whether discharged by one or several joint commissioners, called Lords of the Admiralty.

ADMIRALTY-*Court*, or Court of Admiralty, in the British polity, a sovereign court, held by the Lord High Admiral, or the Commissioners of the Admiralty.

This court has cognizance in all maritime affairs, civil as well as criminal. All crimes committed on the high-seas, or in great rivers, beneath the bridge next the sea, are cognizable only in this court; which, by statute, is obliged to try the same by judge and jury. But in civil causes it is otherwise, these being all determined according to the civil law; the reason whereof is, because the sea is without the jurisdiction of the common law.

In case any person be sued in the admiralty-court, contrary to the statutes, he may have the writ of supesedeas to stop farther proceedings, and also an action for double damages against the person suing.

Subordinate to this court, there is another of equity, called Court-merchant; wherein all causes between merchants are decided, agreeable to the rules of the civil law.

ADOLIA, in botany, a genus of plants found among the trees at Malabar, which bear a near relation to the rhamnus. There are two species, viz. A. alba, with white flowers, which grows to the height of seven or eight feet, and bears fruit twice a year: the berries when ripe are of a purplish black colour: and A. rubra, with red flowers; but the berries when ripe are of an orange colour, and of an acid taste.

ADONIS, *Pheasant's Eye*, or *Red Maiths*, in botany, a genus of the Polyandria Polygynia class of plants, the calyx of

which is a perianthium composed of five obtuse, hollow, somewhat coloured and deciduous leaves; the corolla consists of five oblong obtuse beautiful petals; and sometimes there are more than five: there is no pericarpium; the receptacle is oblong, spicated, and holds five series of seeds; the seeds are numerous, irregular, and angular, gibbous at the base, and their apex reflex and prominent. There are six species, viz. the A. æstivalis, or tall, which is a native of the southern countries of Europe, where it grows among corn: the A. autumnalis, or common, which are found in Kent, near the Medway, in fields sown with wheat; the flowers are brought in great quantities to London, where they are sold under the name of Red Morocco: this is annual, and flowers from May to October: A. vernalis, or spring adonis, is found in Switzerland, Prussia, and some parts of Germany: A. apennina is found wild in Siberia: A. vescatoria, or blister adonis; and the A. capensis, are used by the Africans for raising blisters. To these have been added two other species, viz. the miniata and the flammea.

ADOXA, in botany, a genus of the Octandria Tetragynia class of plants, the corolla of which is plain, and consists of a single petal, divided into four oval acute segments, longer than the cup; the fruit is a globose berry, situated between the calyx and corolla; the calyx adheres to its under part; the berry is umbilicated, and contains four cells; the seeds are single and compressed. There is but a single species, viz. the A. moschatellina, bulbous fumitory, which grows naturally in shady places and woods, as in Hampstead and Charlton woods; it is perennial: flowers in April and May. The leaves soon after decay, and the flowers smell like musk, on which account it has sometimes been called musk-crowfoot.

AD QUOD DAMNUM, in law, a writ which ought to be issued before the king grants certain liberties, as a fair, market, or the like; ordering the sheriff to inquire by the country what damage such a grant is like to be attended with.

ADRIFT, in naval affairs, the state of a vessel broken loose from her moorings, and driven to and fro by the winds or waves.

ADVERB, *adverbium*, in grammar, a word joined to verbs, expressing the manner, time, &c. of an action: thus, in the phrase, *it is conducive to health to rise early;* the word *early* is an adverb; and so of others.

ADVERSARIA, among the ancients, was a book of accounts, not unlike our journals or day-books.

Adversaria is more particularly used among men of letters, for a kind of common-place book, wherein they enter whatever occurs to them worthy of notice, whether in reading or conversation, in the order in which it occurs: a method which Morhof prefers to that of digesting them under certain heads.

ADVOCATE, *Lord*, one of the officers of state in Scotland, who pleads in all causes of the crown, or wherein the king is concerned.

The lord advocate sometimes happens to be one of the lords of session; in which case, he only pleads in the king's causes.

ADVOWSON, in law, is the right of patronage, or presenting to a vacant benefice.

Advowsons, are either appendant, or in gross. Appendant advowsons are those which depend on a manor, or lands, and pass as appurtenances of the same: whereas advowson in gross is a right of presentation subsisting by itself, belonging to a person, and not to lands.

In either case, advowsons are no less the property of the patrons than their landed estate: accordingly they may be granted away by deed or will, and are assets in the hands of executors. However, Papists and Jews, seized of any advowsons, are disabled from presenting: the right of presentation being in this case transferred to the chancellors of the universities, or the bishop of the diocese.

Advowsons are also presentative, collative, or donative. Presentative, where the patron hath a right of presentation to the bishop or ordinary; collative, where the bishop is patron; and donative, where the king, or any subject. This licence founds a church or chapel, and ordains that it shall be merely in the gift of the patron.

ADZE, a cutting-tool, of the axe kind, having its blade thin and arching, and its edge at right angle to the handle; chiefly used for taking thin chips off timber, &c. It is used by carpenters, but more frequently by coopers.

ÆCIDIUM, in botany, a genus of the Cryptogamia Fungi class and order. Its characters are, that it has a membranaceous sheath, smooth on both sides, and full of naked separate sides. There are 18 species, of which, several are found on the leaves of other plants, and one of them is known to agriculturists by the name of *red gum.*

This species usually grows upon the inside of the glumes of the calyx, and of the exterior valvule of the corolla, under their epidermes, which, when the plant is ripe, bursts, and emits a powder of a bright orange colour. Other species grow on decaying wood and mosses, and in the leaves of tussilago, farfara, &c.

ÆGICERAS, a genus of the Pentandria Monogynia class and order: calyx five-cleft; petals five; capsule curved; one-celled; one-valved; one-seeded: two species found in the Moluccas.

ÆGILOPS, *goat's-face*, in botany, a genus of the Triandria Digynia class and order, and of the natural order of grasses: the characters are, that the hermaphrodite calyx is a large bivalvular glume, sustaining three flowers; the valves are ovate, and streaked with various awns: the nectary two-leaved, with very small leaflets: the stamina have three capillary filaments with oblong anthers: the pistillum is a turbinate germen: no pericardium: the seeds are oblong, convex on one side, grooved on the other, with the inner valve of the corolla adhering to it, and not opening. There are six species.

ÆGINETA, in botany, a genus of the Didynamia Angiosperma class and order: calyx one-leafed, spathaceous; corolla campanulate, two-lipped; capsule many celled: one species, viz. the Æ. Indica, found at Malabar.

ÆGIPHILA, *goat's-friend*, a genus of the Tetrandria Monogynia class and order, and the natural order of Vitices: the calyx is a one-leafed permanent perianthium; the corolla is one-petalled, and longer than the calyx; the stamina are capillary filaments inserted into the mouth of the tube; the pistillum is a roundish superior germ, style capillary, deeply bifid, and stigmas simple: the pericarpium is a roundish two-celled berry, surrounded with a permanent calyx; and the seed is either in pairs or solitary. There are seven species, natives of the W. Indies, chiefly of Jamaica.

ÆGLE, in botany, a genus of the Polyandria Monogynia class and order: calyx five-lobed; petals five; berry globular, many celled, with numerous seeds in each. One species, viz. the marmelos, a tree with thorny branches; fruit delicious to the taste, and exquisitely fragrant: seeds imbedded in an extremely tenacious transparent gluten.

ÆGOPODIUM, in botany, a genus of the Pentandria Digynia class of plants; the general corolla whereof is uniform; the single flowers consist each of five, oval, concave, and nearly equal petals; the fruit is naked, ovato-oblong, striated, and separable into two parts; the seeds are two, ovato-oblong and striated, convex on one side, and plain on the other. There is but one species, viz. Æ. podagraria, gout-weed, which is a perennial, creeping weed, with white flowers, that appear in May or June. It has been used in cases of gout, whence it derives its name. It is boiled for greens, and eaten in Sweden; cows, sheep, and goats eat it. It is found among rubbish in shady places, and in hedges.

ÆGOPRICON, in botany, a genus of the Monandria Trigynia class and order: the male flowers are small, in an ovate ament; their calyx one-leafed: no corolla, the stamina of one filament, longer than the calyx, with an ovate anther; the female flowers are on the same plant, and solitary; the calyx and corolla are the same as the male; the pistillum has an ovate superior germ, three divaricate styles, with simple permanent stigmas; the pericardium is a globular berry; the seeds are solitary, and angular on one side. There is but one species, viz. Æ. betulinum, which is a tree very much branched, with wrinkled bark, and alternate leaves resembling those of the myrtle.

ÆOLIPILE, a hollow metalline ball, in which is inserted a slender neck, or pipe; from whence, after the vessel has been filled with water, and heated, issues a blast of wind with great vehemence.

Great care should be taken that the aperture of the pipe be not stopped when the instrument is put on the fire, otherwise the æolipile will burst with a vast explosion, and may occasion no little mischief. Dr. Plot gives an instance where the æolipile is actually used to blow the fire; the lord of the manor of Effington is bound by his tenure to drive a goose every New-year's day three times round the hall of the lord of Hilton, while Jack of Hilton (a brazen figure having the structure of an æolipile) blows the fire. In Italy, it is said, that the æolipile is commonly made use to cure smoky chimneys; for being hung over the fire, the blast arising from it carries up the loitering smoke along with it.

An æolipile of great antiquity, made of brass, was lately dug up in the site of the Basingstoke canal, and presented to the Antiquarian Society in London. It is not glo-

bular, with a bent tube, but in the form of a grotesque human figure, and the blast proceeds from the mouth.

ÆOLUS'S *harp*, or EOLIAN *harp*, a musical instrument so named from its producing an agreeable harmony merely by the action of the wind. See ACOUSTICS.

ÆRA, a fixed point of time, from which any number of years is begun to be reckoned. See CHRONOLOGY.

AEROSTATION, in the modern application of the term, signifies the art of navigation through the air, both in its principles and practice. Hence also the machines which are employed for this purpose, are called aerostats, or aerostatic machines; and on account of their round figure, air balloons.

The fundamental principles of this art have been long and generally known; although the application of them to practice seems to be altogether a modern discovery. It will be sufficient, therefore, to observe, in this place, that any body, which is specifically, or bulk for bulk, lighter than the atmospheric air encompassing the earth, will be buoyed up by it, and ascend; but as the density of the atmosphere decreases, on account of the diminished pressure of the superincumbent air, and the elastic property which it possesses at different elevations above the earth, this body can rise only to a height in which the surrounding air will be of the same specific gravity with itself. In this situation it will either float, or be driven in the direction of the wind or current of air, to which it is exposed. An air-balloon is a body of this kind, the whole mass of which, including its covering and contents, and the several weights annexed to it, is of less specific gravity than that of the air in which it rises. Heat is well known to rarefy and expand, and consequently to lessen the specific gravity of the air to which it is applied; and the diminution of its weight is proportional to the heat. One degree of heat, according to the scale of Fahrenheit's thermometer, seems to expand the air about one four-hundredth part; and about 400, or rather 435, degrees of heat, will just double the bulk of a quantity of air. If, therefore, the air inclosed in any kind of covering be heated and consequently dilated to such a degree, as that the excess of the weight of an equal bulk of common air above the weight of the heated air, is greater than the weight of the covering and its appendages, this whole mass will ascend in the atmosphere, till, by the cooling and condensation of the included air, or the diminished density of the surrounding air, it becomes of the same specific gravity with the air in which it floats; and without renewed heat, it will gradually descend. If, instead of heating common air inclosed in any covering, and thus diminishing its weight, the covering be filled with an elastic fluid, lighter than atmospheric air, so that the excess of the weight of an equal bulk of the latter above that of the inclosed elastic fluid be greater than the weight of the covering and its appendages, the whole mass will, in this case, ascend in the atmosphere, and continue to rise till it attains a height at which the surrounding air is of the same specific gravity with itself. Inflammable air, or, as it is called, hydrogen gas, is a fluid of this kind. For the knowledge of many of its properties we are indebted to Mr. Henry Cavendish, who discovered that, if common air is eight hundred times lighter than water, inflammable air is seven times lighter than common air; but if common air is eight hundred and fifty times lighter than water, then inflammable air is 10.8 times lighter than common air. The construction of air-balloons depends upon the principles above stated; and they are of two kinds, as one or the other of the preceding methods of preparing them is adopted.

In the various schemes that have been proposed for navigating through the air, some have had recourse to artificial wings; which, being constructed like those of birds, and annexed to the human body, might bear it up, and by their motion, produced either by mechanical springs, or muscular exertion, effect its progress in any direction at pleasure. This is one of the methods of artificial flying suggested by Bishop Wilkins, in the seventh chapter of his "Dedalus, or Treatise on Mechanical Motions;" but the success of it is doubtful, and experiments made in this way have been few and unsatisfactory. Borelli having compared the power of the muscles which act on the wings of a bird with that of the muscles of the breast and arms of a man, finds the latter altogether insufficient to produce, by means of any wings, that motion against the air, which is necessary to raise a man in the atmosphere. Soon after Mr. Cavendish's discovery of the specific gravity of inflammable air, it occurred to the ingenious Dr. Black, of Edinburgh, that if a bladder, sufficiently light and thin, were filled with this air, it would form a mass lighter than the same bulk of at-

mospheric air, and rise in it. This thought was suggested in his lectures in 1767 or 1768; and he proposed, by means of the allantois of a calf, to try the experiment. Other employments, however, prevented the execution of his design. The possibility of constructing a vessel, which, when filled with inflammable air, would ascend in the atmosphere, had occurred also to Mr. Cavallo, about the same time; and to him belongs the honour of having first made experiments on this subject, in the beginning of the year 1782, of which an account was read to the Royal Society, on the 20th of June in that year. He tried bladders; but the thinnest of these, however scraped and cleaned, were too heavy. In using China paper, he found that the inflammable air passed through its pores, like water through a sieve; and having failed of success by blowing this air into a thick solution of gum, thick varnishes, and oil-paint, he was under a necessity of being satisfied with soap-bubbles, which being inflated with inflammable air, by dipping the end of a small glass tube, connected with a bladder containing air, into a thick solution of soap, and gently compressing the bladder, ascended rapidly in the atmosphere; and these were the first sort of inflammable air-balloons that were ever made. For balloons formed on a larger scale, and on the principle of rarefied air, we must direct our attention to France, where the two brothers, Stephen and Joseph Montgolfier, paper-manufacturers at Annonay, about 36 miles from Lyons, distinguished themselves by exhibiting the first of those aerostatic machines, which have since excited so much attention and astonishment. The first idea of such a machine was suggested to them by the natural ascent of the smoke and clouds in the atmosphere; and the first experiment was made at Avignon, by Stephen, the eldest of the two brothers, towards the middle of November 1782. Having prepared a bag of fine silk, in the shape of a paralelepipedon, and in capacity about 40 cubic feet, he applied to its aperture burning paper, which rarefied the air, and thus formed a kind of cloud in the bag, and when it became sufficiently expanded, it ascended rapidly to the ceiling. Soon afterwards the experiment was repeated by the two brothers at Annonay in the open air, when the machine ascended to the height of about seventy feet. Encouraged by their success, they constructed a machine, the capacity of which was about 650 cubic feet, which, in the experiment, broke the ropes that confined it, and after ascending rapidly to the height of about 600 feet fell on the adjoining ground. With another machine, 35 feet in diameter, they repeated the experiment in April 1783, when breaking loose from its confinement, it rose to the height of above 1000 feet, and being carried by the wind, it fell at the distance of about three quarters of a mile from the place where it ascended. The capacity of this machine was equal to about 23,430 cubic feet; and when inflated, it measured 117 English feet in circumference. The covering of it was formed of linen lined with paper, its shape was nearly spherical, and its aperture was fixed to a wooden frame about 16 feet in surface. When filled with vapour, which was conjectured to be about half as heavy as common air, it was capable of lifting up about 490 pounds, besides its own weight, which, together with that of the wooden frame, was equal to 500 pounds. With this machine the next experiment was performed at Annonay, on the 5th of June 1783, before a great multitude of spectators. The flaccid bag was suspended on a pole 35 feet high; straw and chopped wool were burnt under the opening at the bottom; the vapour, or rather smoke, soon inflated the bag, so as to distend it in all its parts; and this immense mass ascended in the air with such a velocity, that in less than ten minutes it reached the height of about 6000 feet. A breeze carried it in an horizontal direction to the distance of 7668 feet; and it then fell gently on the ground. M. Montgolfier attributed the ascent of the machine, not to the rarefaction of the heated air, which is the true cause, but to a certain gas or aeriform fluid, specifically lighter than common air, which was supposed to be disengaged from burning substances, and which has been commonly called Montgolfier's gas, as baloons of this kind have been denominated Montgolfiers. As soon as the news of this experiment reached Paris, the philosophers of the city, conceiving that a new sort of gas, half as heavy as common air, had been discovered by Messrs. Montgolfier; and knowing that the weight of inflammable air was not more than the eighth or tenth part of the weight of common air, justly concluded, that inflammable air would answer the purpose of this experiment better than the gas of Montgolfier, and resolved to make trial of it. A subscription was opened by M. Faujas de St. Fond towards defraying the expense of the experiment. A sufficient

sum of money having been soon raised, Messrs. Roberts were appointed to construct the machine; and M. Charles, professor of experimental philosophy, to superintend the work. After surmounting many difficulties in obtaining a sufficient quantity of inflammable air, and finding a substance light enough for the covering, they at length constructed a globe of lutestring, which was rendered impervious to the inclosed air by a varnish of elastic gum, or caoutchouc, dissolved in some kind of spirit or essential oil. The diameter of this globe, which, from its shape, was denominated a balloon, was about thirteen feet, and it had only one aperture, like a bladder, to which a stop-cock was adapted: its weight, when empty, together with that of the stop-cock, was 25 pounds. On the 23d of August, 1783, they began to fill the globe with inflammable air; but this, being their first attempt, was attended with many hindrances and disappointments. At last, however, it was prepared for exhibition; and on the 27th it was carried to the Champ de Mars, where, being disengaged from the cords that held it down, it rose before a prodigious concourse of people, in less than two minutes, to the height of 3123 feet. It then entered a cloud, but soon appeared again; and at last it was lost among other clouds. This balloon, after having floated about three quarters of an hour, fell in a field about 15 miles distant from the place of ascent; where, as we may naturally imagine, it occasioned much astonishment to the peasants. Its fall was owing to a rent, occasioned by the expansion of the inflammable air in that part of the atmosphere to which it ascended. When the balloon went up, its specific gravity was 35 pounds less than that of common air. In consequence of this brilliant experiment, many balloons were made on a small scale; goldbeaters skin was used for the covering; and their size was from 9 to 18 inches in diameter.

Mr. Montgolfier repeated an experiment with a machine of his construction before the commissaries of the Academy of Sciences, on the 11th and 12th of September. This machine was 74 feet high, and about 43 feet in diameter. When distended, it appeared spheroidical. It was made of canvas, covered with paper both within and without, and it weighed 1000 pounds. The operation of filling it with rarefied air, produced by means of the combustion of 50 pounds of dry straw, and 12 pounds of chopped wool, was performed in about nine minutes; and its force of ascension, when inflated, was so great, that it raised eight men who held it some feet from the ground. This machine was so much damaged by the rain, that it was found necessary to prepare another for exhibition before the king and royal family on the 19th. This new machine consisted of cloth, made of linen and cotton thread, and was painted with water-colours both within and without. Its height was near 60 feet, and its diameter about 43 feet. Having made the necessary preparations for inflating it, the operation was begun about one o'clock on the 19th of September, before the king and queen, the court, and all the Parisians who could procure a conveyance to Versailles. In eleven minutes it was sufficiently distended, and the ropes being cut, it ascended, bearing up with it a wicker cage, in which were a sheep, a cock, and a duck. Its power of ascension, or the weight by which it was lighter than an equal bulk of common air, allowing for the cage and animals, was 696 pounds. This balloon rose to the height of about 1440 feet; and being driven by the wind, it descended gradually, and fell gently into a wood, at the distance of 10,200 feet from Versailles. After remaining in the atmosphere eight minutes, the animals in the cage were safely landed. The sheep was found feeding; the cock had received some hurt on one of his wings, probably from a kick of the sheep; the duck was perfectly well. The success of this experiment induced M. Pilatre de Rozier, with a philosophical intrepidity which will be recorded with applause in the history of aerostation, to offer himself as the first adventurer in this aerial navigation. Mr. Montgolfier constructed a new machine for this purpose in a garden in the Fauxbourg St. Antoine. Its shape was oval; its diameter being about 48 feet, and its height about 74 feet. To the aperture at the bottom was annexed a wicker gallery, about three feet broad, with a ballustrade about three feet high. From the middle of the aperture was suspended by chains, which came down from the sides of the machine, an iron grate, or brazier, in which a fire was lighted for inflating the machine; and port-holes were opened in the gallery, towards the aperture, through which any person, who should venture to ascend, might feed the fire on the grate with fuel, and regulate the dilatation of the inclosed air of the machine at pleasure. The weight of the aerostat was upwards of 1600 pounds. On the 15th of October, the fire

being lighted, and the machine inflated, M. P. de Rozier placed himself in the gallery, and ascended, to the astonishment of a multitude of spectators, to the height of 84 feet from the ground and there kept the machine afloat during 4′ 25″, by repeatedly throwing straw and wool upon the fire: the machine then descended gradually and gently, through a medium of increasing density, to the ground; and the intrepid adventurer assured the spectators that he had not experienced the least inconvenience in this aerial excursion. This experiment was repeated on the 17th and on the 19th, when M. P. de Rozier, in his descent, and in order to avoid danger by reascending, evinced to a multitude of observers, that the machine may be made to ascend and descend at the pleasure of the aeronaut, by merely increasing or diminishing the fire in the grate. The balloon having been hauled down, M. Giraude de Villiette placed himself in the gallery opposite to M. Rozier; and being suffered to ascend, it hovered for about nine minutes over Paris in the sight of all its inhabitants at the height of about 330 feet. In another experiment the Marquis of Arlandes ascended with M. Rozier much in the same manner. In consequence of the report of the preceding experiment, signed by the commissaries of the Academy of Sciences, it was ordered that the annual prize of 600 livres should be given to Messrs. Montgolfier for the year 1783. In the experiments above recited the machine was secured by ropes; but they were soon succeeded by unconfined aerial navigation. Accordingly the balloon of 74 feet in height, above mentioned, was removed to a royal palace in the Bois de Boulogne: and all things being ready, on the 21st of November M. P. de Rozier and the Marquis d'Arlandes took their respective posts in the gallery, and at 54 minutes after one the machine was absolutely abandoned to the element, and ascended calmly and majestically in the atmosphere. The aeronauts having reached the height of about 280 feet, waved their hats to the astonished multitude: but they soon rose too high to be distinguished, and are thought to have soared to an elevation of above 3000 feet. They were at first driven by a north-west wind horizontally over the river Seine and over Paris, taking care to clear the steeples and high buildings by increasing the fire; and in rising met with a current of air, which carried them southward. Having passed the Boulevard, and desisting from supplying the fire with fuel, they descended very gently in a field beyond the New Boulevard, about 9000 yards distant from the palace, having been in the air about 25 minutes. The weight of the whole apparatus, including that of the two travellers, was between 1600 and 1700 pounds. Notwithstanding the rapid progress of aerostation in France, we have no authentic account of the aerostatic experiments performed in other countries till about the close of the year 1783. The first experiment of this kind, publicly exhibited in our own country, was performed in London on the 25th of November, by Count Zambeccari, an ingenious Italian, with a baloon of oil silk, 10 feet in diameter, and weighing 11 pounds. It was gilt, in order to render it more beautiful and more impermeable to the gas. This balloon, three-fourths of which were filled with inflammable air, was launched from the Artillery-Ground in the presence of a vast concourse of spectators, at one o'clock in the afternoon, and at half past three was taken up near Petworth, in Sussex, 48 miles distant from London; so that it travelled at the rate of nearly 20 miles an hour. Its descent was occasioned by a rent, which must have been the effect of the rarefaction of the inflammable air, when the balloon ascended to the lighter parts of the atmosphere.

Aerostatic experiments and aerial voyages became so frequent in the course of the year 1784, that the limits of this article will not allow our particularly recording them. We shall, therefore, merely mention those which were attended with any peculiar circumstances. Messrs. de Morveau and Bertrand ascended from Dijon in April, to the height of about 13,000 feet, with an inflammable air balloon: the thermometer was observed to stand at 25 degrees. They were in the air during an hour and 25 minutes, and went to the distance of about eighteen miles. The clouds floated beneath them, and secluded them from the earth: and they jointly repeated the motto inscribed on their aerostat:—"Surgit nunc gallus ad aethera." In May, four ladies and two gentlemen ascended with a Montgolfier at Paris above the highest buildings: the machine was confined by ropes. It was 74 feet high, and 72 in diameter. In a second voyage, performed by Mr. Blanchard from Rouen in May, it was observed, that his wings and oars could not carry him in any other direction than that of the wind. The mercury in the barometer descended as low as 20.57 inches;

but on the earth, before he ascended, it stood at 30.16 inches. On the 23d of June, a large aerostat, on the principle of rarefied air, $91\frac{1}{2}$ feet high, and 79 feet in diameter, was elevated by Montgolfier at Versailles, in the presence of the royal family and the King of Sweden. M. Pilatre de Rozier, and M. Proust, ascended with it, and continued for 28 minutes at the height of 11,732 feet, and observed the clouds below them, that reflected to the region which they occupied the rays of the sun; the temperature of the air being 5° below the freezing point; and in three quarters of an hour they travelled to the distance of 36 miles. In consequence of this experiment, the king granted to M. Rozier a pension of 2000 livres. On the 15th of July the Duke of Chartres, the two brothers Roberts, and another person, ascended with an inflammable air balloon, of an oblong form, $55\frac{1}{2}$ feet long, and 34 feet in diameter, from the Park of St. Cloud: the machine remained in the atmosphere about 45 minutes. This machine contained an interior small balloon, filled with common air, by which means it was proposed to make it ascend or descend without any loss of inflammable air or ballast. The boat was furnished with a helm and oars, intended for guiding it. At the place of departure the barometer stood at 30.12 inches. Three minutes after ascending, the balloon was lost in the clouds, and involved in a dense vapour. An agitation of the air, resembling a whirlwind, alarmed the aerial voyagers, and occasioned several shocks, which prevented their using any of the instruments and contrivances prepared for the direction of the balloon. Other circumstances concurred to increase their danger; and when the mercury standing in the barometer at 24.36 inches indicated their height to be about 5100 feet, they found it necessary to make holes in the bottom for discharging the inflammable air: and having made a rent of between seven and eight feet, they descended very rapidly, and at last came safely to the ground. The first aerial voyage in England was performed in London, on the 15th of September, by Vincent Lunardi, a native of Italy. His balloon was made of oiled silk, painted in alternate stripes of blue and red. Its diameter was 33 feet. From a net which went over about two-thirds of the balloon, descended 45 cords to a hoop hanging below the balloon, and to which the gallery was attached. The balloon had no valve; and its neck, which terminated in the form of a pear, was the aperture through which the inflammable air was introduced, and through which it might be let out. The air for filling the balloon was produced from zinc by means of diluted vitriolic acid. M. Lunardi departed from the Artillery Ground at two o'clock; and with him were a dog, a cat, and a pigeon. After throwing out some sand, to clear the houses, he ascended to a great height. The direction of his motion was at first north-west by west; but as the balloon rose higher, it fell into another current of air, which carried it nearly north. About half after three he descended very near the ground, and landed the cat, which was almost dead with cold: then rising, he prosecuted his voyage. He ascribes his descent to the action of an oar; but as he was under the necessity of throwing out ballast in order to re-ascend, his descent was more probably occasioned by the loss of inflammable air. At ten minutes past four he descended on a meadow, near Ware, in Hertfordshire. The only philosophical instrument which he carried with him was a thermometer, which in the course of his voyage stood as low as 29°, and he observed that the drops of water which collected round the balloon were frozen.

The longest and the most interesting voyage, which was performed about this time, was that of Messrs. Roberts and M. Collin. Hullin, at Paris, on the 19th of September. Their aerostat was filled with inflammable air. Its diameter was $27\frac{3}{4}$ feet, and its length $46\frac{3}{4}$ feet, and it was made to float with its longest part parallel to the horizon, with a boat of nearly 17 feet long attached to a net that went over it as far as its middle. To the boat were annexed wings, or oars, in the form of an umbrella. At 12 o'clock they ascended with 450 pounds of ballast, and after various manœuvres descended at 40 minutes past six o'clock near Arras, in Artois, having still 200 pounds of their ballast remaining in the boat. Having risen about 1400 feet, they perceived stormy clouds, which they endeavoured to avoid; but the current of air was uniform from the height of 600 to 4200 feet. The barometer on the coast of the sea was 29.61 inches, and sunk to 23.94 inches. They found that by working with their oars, they accelerated their course. In the prosecution of their voyage, which was 150 miles, they heard two claps of thunder; and the cold occasioned by the approach of stormy clouds made the thermometer fall from 77° to 59°, and condensed the inflammable air in the balloon, so as to make it descend very

low. From some experiments they concluded, that they were able by the use of two oars to deviate from the direction of the wind about 22°. But this experiment requires repetition, in order to ascertain with accuracy the effect here ascribed to oars. The second aerial voyage in England was performed by Mr. Blanchard and Mr. Sheldon, professor of anatomy to the Royal Academy, the first Englishman who ascended with an aerostatic machine. This experiment was performed at Chelsea on the 16th of October. The wings used on this occasion seemed to have produced no deviation in the machine's track from the direction of the wind. Mr. Blanchard, having landed his friend about the distance of 14 miles from Chelsea, proceeded alone with different currents, and ascended so high as to experience great difficulty of breathing: a pigeon also, which flew away from the boat, laboured for some time with its wings, in order to sustain itself in the rarefied air, and after wandering for a good while, returned and rested on one side of the boat. Mr. Blanchard perceiving the sea before him, descended near Rumsey, about 75 miles from London, having travelled at the rate of nearly 20 miles an hour.

On the 12th of October, Mr. Sadler, of Oxford, made a voyage of 14 miles from that place in 17 minutes, with an inflammable air balloon of his own contrivance and construction. The fate of M. P. de Rozier, the first aerial navigator, and of his companion M. Romain, has been much lamented. They ascended at Boulogne on the 15th of June, with an intention of crossing the channel to England. Their machine consisted of a spherical balloon, 37 feet in diameter, filled with inflammable air, and under this balloon was suspended a small Montgolfier, or fire balloon, ten feet in diameter. This Montgolfier was designed for rarefying the atmospheric air, and thus diminishing the specific gravity of the whole apparatus. For the first twenty minutes they seemed to pursue the proper course; but the balloon seemed to be much inflated, and the aeronauts appeared anxious to descend. Soon, however, when they were at the height of about three quarters of a mile, the whole apparatus was in flames, and the unfortunate adventurers fell to the ground, and were killed on the spot.

On the 19th of July Mr. Crosbie ascended at Dublin, with a view of crossing the channel to England. To a wicker basket of a circular form, which he had substituted for the boat, he had affixed a number of bladders, for the purpose of rendering his gallery buoyant, in case of a disaster at sea. The height to which he ascended at one time was such, that by the intense cold his ink was frozen, and the mercury sunk into the ball of the thermometer. He himself was sick, and he felt a strong impression on the tympanum of his ears. At his utmost elevation he thought himself stationary; but on discharging some gas he descended to a very rough current of air blowing to the north. He then entered a dense cloud, and experienced strong blasts of winds, with thunder and lightning, which brought him with rapidity towards the surface of the water. The water soon entered his car; the force of the wind plunged him into the ocean, and it was with difficulty that he put on his cork jacket. The bladders which he had prepared were now found of great use. The water, added to his own weight, served as ballast; and the balloon maintaining its poise, answered the purpose of a sail, by means of which, and a snatch-block to his car, he moved before the wind as regularly as a sailing-boat. He was at length overtaken by some vessels that were crowding sail after him, and conveyed to Dunleary with the balloon. On the 22d of July, Major Money, who ascended at Norwich, was driven out to sea, and after having been blown about for about two hours, he dropped into the water. After much exertion for preserving his life, and when he was almost despairing of relief, he was taken up by a revenue cutter in a state of extreme weakness: having been struggling to keep himself above water for about seven hours.

The longest voyage that had been hitherto made was performed by Mr. Blanchard, towards the end of August. He ascended at Lisle, accompanied by the Chevalier de L'Epinard, and traversed a distance of 300 miles before they descended. On this, as well as on other occasions, Mr. Blanchard made trial of a parachute, in the form of a large umbrella, which he contrived for breakin his fall in case of any accident. With this machine he let down a dog, which came to the ground gently, and unhurt. On the 8th of September Mr. Baldwin ascended from the city of Chester, and performed an aerial voyage of 25 miles in two hours and a quarter. His greatest elevation was about a mile and a half, and he supposes that the velocity of his motion was sometimes at the rate of 20 miles an hour. He has published a circumstantial account of his voyage, de-

scribed the appearances of the clouds as he passed through them, and annexed a variety of observations relating to aerostation.

It would be tedious to recount the aerial expeditions that were performed in various parts of our own country, as well as on the continent, in the whole course of the year 1785: more especially as they have afforded us no experiment or discovery of any peculiar importance. The most persevering aerial navigator has been Mr. Blanchard. In August, 1788, he ascended at Brunswick for the thirty-second time. Within two years from the first discovery of this art of navigating the atmosphere, more than forty different persons performed the experiment without any material injury; and it may be justly questioned, says Mr. Cavallo, whether the first forty persons who trusted themselves to the sea in boats escaped so safely. The catastrophe that befel Rozier, and the unpleasant circumstances that have happened to some of the aeronauts in our own country, have been owing not so much to the principle of the art, as to want of judgment, or imprudent management in the conduct of it.

Omitting the various uninteresting, though not very numerous aerial voyages undertaken in various parts of the world, during the 17 years subsequent to the above-mentioned dreadful accident of Pilatre de Rozier and Mr. Romain, we shall only add the account of two aerostatic experiments lately performed in England by Mr. Garnerin, a French aeronaut. The first of these is remarkable for the very great velocity of its motion; the second for the exhibition of a mode of leaving the balloon, and of descending with safety to the ground. On the 30th of June, 1802, the wind being strong, though not impetuous, Mr. Garnerin and another gentleman ascended with an inflammable air, or hydrogen gas balloon, from Ranelagh gardens, on the south-west of London, between four and five o'clock in the afternoon; and in exactly three quarters of an hour they descended near the sea, at the distance of four miles from Colchester. The distance of that place from Ranelagh is 60 miles; therefore they travelled at the astonishing rate of 80 miles per hour. It seems that the balloon had power enough to keep them up four or five hours longer, in which time they might have gone safely to the continent; but prudence induced them to descend when they discovered the sea not far off. The singular experiment of ascending into the atmosphere with a balloon, and of descending with a machine called a parachute, was performed by Mr. Garnerin on the 21st of September, 1802. He ascended from St. George's parade, North Audley Street, and descended safe into a field near the small-pox hospital, at Pancras. The balloon was of the usual sort, viz. of oiled silk, with a net, from which ropes proceeded, which terminated in, or were joined to a single rope at a few feet below the balloon. To this rope the parachute was fastened in the following manner. The reader may easily form to himself an idea of this parachute, by imagining a large umbrella of canvas, of about 30 feet in diameter, but destitute of the ribs and handle. Several ropes, of about 30 feet in length, which proceeded from the edge of the parachute, terminated in a common joining, from which shorter ropes proceeded, to the extremities of which a circular basket was fastened, and in this basket Mr. Garnerin placed himself. The single rope passed through a hole in the centre of the parachute, also through certain tin tubes, which were placed one after the other in the place of the handle or stick of an umbrella, and was lastly fastened to the basket; so that when the balloon was in the air, by cutting the end of the rope next to the basket, the parachute, with the basket, would be separated from the balloon, and, in falling downwards, would be naturally opened by the resistance of the air. The use of the tin tubles was to let the rope slip off with greater certainty, and to prevent its being entangled with any of the other ropes, as also to keep the parachute at a distance from the basket. The balloon began to be filled about two o'clock. There were 36 casks, filled with iron filings, and diluted sulphuric acid, for the production of the hydrogen gas. These communicated with three other casks, or general receivers, to each of which was fixed a tube that emptied itself into the main tube attached to the balloon. At six, the balloon being quite full of gas, and the parachute, &c. being attached to it, Mr. Garnerin placed himself in the basket, and ascended majestically amidst the acclamations of innumerable spectators. The weather was the clearest and pleasantest imaginable; the wind was gentle, and about west by south; in consequence of which Mr. Garnerin went in the direction of nearly east by north. In about eight minutes the balloon and parachute had ascended to an immense height, and Mr. Garnerin, in the basket, could scarcely be perceived. While every spectator was contemplating the

grand sight before them, Mr. Garnerin cut the rope, and in an instant he was separated from the balloon, trusting his safety to the parachute. At first, viz. before the parachute opened, he fell with great velocity; but as soon as the parachute was expanded, which took place a few moments after, the descent became very gentle and gradual. A remarkable circumstance was observed; namely, that the parachute, with the appendage of cords and basket, soon began to vibrate like the pendulum of a clock, and the vibrations were so great, that more than once the parachute, and the basket with Mr. Garnerin, seemed to be on the same level, or quite horizontal: however, the extent of the vibrations diminished as he descended. On coming to the earth, Mr. Garnerin experienced some pretty strong shocks; but he soon recovered his spirits, and remained without any material hurt. As soon as the parachute was separated from the balloon, the latter ascended with great rapidity, and, being of an oval form, turned itself with its longer axis into an horizontal position.

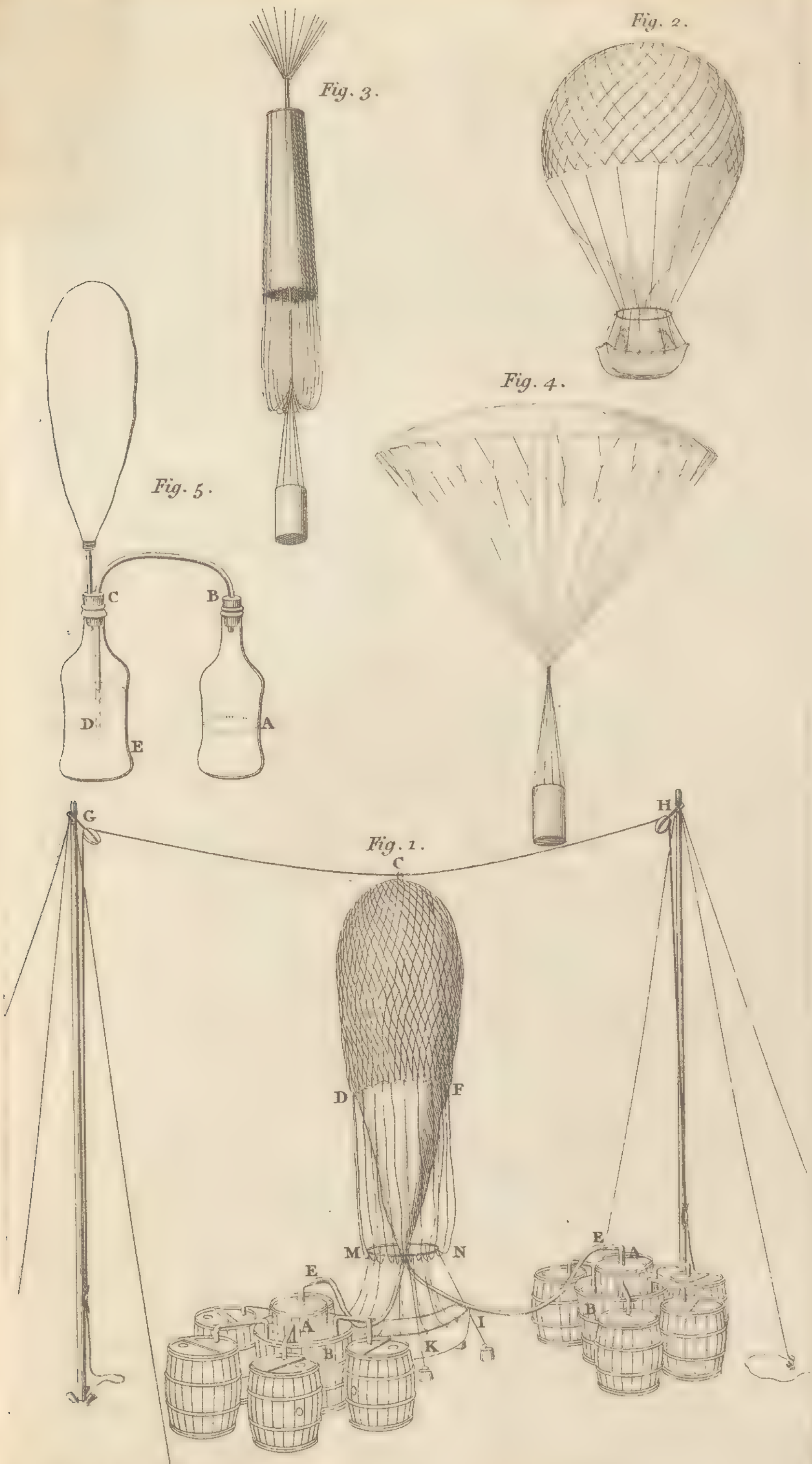
We now come to the practice of the art. The shape of the balloon is one of the first objects of consideration. As a sphere admits the greatest capacity under the least surface, the spherical figure, or that which approaches nearest to it, has been generally preferred. However, since bodies of this form oppose a greater surface to the air, and consequently a greater obstruction to the action of the oar or wings than those of some other form, and therefore cannot be so well guided in a calm, or in a course different from the direction of the wind, it has been proposed to construct balloons of a conical or oblong figure, and to make them proceed with their narrow end forward. Next to the shape, it is necessary to consider the stuff that is most proper for forming the envelope of the inflammable or rarefied air. Silk stuff, especially that which is called lutestring, properly varnished, has been most commonly used for hydrogen gas balloons: and common linen, lined within and without with paper, varnished, for those of rarefied air. Varnished paper, or gold beater's skin, will answer the purpose for making small hydrogen gas balloons; and the small rarefied air balloons may be made of paper, without any varnish or other preparation. The stuff for large balloons of both kinds requires some previous preparation. The best mode of preparing the cloth for a machine upon Montgolfier's principle, is first to soak it in a solution of sal-ammoniac and size, using one pound of each to every gallon of water; and when the cloth is quite dry, to paint it over with some earthy colour, and strong size or glue. It may be also varnished over when perfectly dry, with some stiff, oily varnish, or simple drying linseed oil, which would dry before it penetrates quite through the cloth. The pieces of which an hydrogen gas balloon is to be formed must be cut of a proper size, according to the proposed dimensions of it, when the varnish is sufficiently dry. The pieces that compose the surface of the balloon are like those gores that form the superficies of a globe: and the best method of cutting them is to describe a pattern of wood or stiff card-paper, and to cut the silk or stuff upon it. To the upper part of the balloon there must be adapted a valve, opening inward, to which is annexed a string passing through a hole made in a small round piece of wood, which is fastened to the lowest part of the balloon, opposite to the valve, to the boat below it; so that the aeronaut may open it as occasion requires, and let the hydrogen gas out of the balloon. To the lower part of the balloon are fixed two pipes of the same stuff with the covering, six inches in diameter for a balloon of 30 feet, and much larger for balloons of greater size, and long enough to reach the boat. These pipes are the apertures through which the hydrogen gas is introduced into the balloon. The boat may be made of wicker work, and covered with leather, well painted or varnished over. The best method of suspending it is by means of ropes, proceeding from the net which goes over the balloon. This net should be formed to the shape of the balloon, and fall down to the middle of it, and have various cords proceeding from it to the circumference of a circle, about two feet below the balloon; and from that circle other ropes should go to the edge of the boat. This circle may be made of wood, or of several pieces of slender cane bound together. The meshes of the net may be small at top, against which part of the balloon the hydrogen gas exerts the greatest force, and increase in size as they recede from the top. A hoop has been sometimes put round the middle of the balloon for fastening the net. This is not absolutely necessary; but when used, it is best made of pieces of cane bound together, and covered with leather. When the balloon and its appendages are constructed, the next object of importance is to procure proper materials for filling it. Hydrogen gas for balloons may be obtained

in several ways: but the best methods are by applying acids to certain metals; by exposing animal, vegetable, and some mineral substances, in a close vessel, to a strong fire; or by transmitting the vapour of certain fluids through red-hot tubes. In the first of these methods, iron, zinc, and sulphuric acid are the materials most commonly used. The acid must be diluted with five or six parts of water. Iron may be expected to yield in the common way about 1700 times its own bulk of gas; or $4\frac{1}{2}$ ounces of iron, the like weight of sulphuric acid, and $22\frac{1}{2}$ ounces of water, will produce one cubic foot of hydrogen gas; 6 ounces of zinc, an equal weight of acid, and 30 ounces of water, are necessary for producing the same quantity. It is more proper to use the turnings or chippings of great pieces of iron, as of cannon, &c. than the filings of that metal, because the heat attending the effervescence will be diminished, and the diluted acid will pass more readily through the interstices of the turnings, when they are heaped together, than through the filings, which stick closer to one another. The weight of the hydrogen gas thus obtained by means of sulphuric acid, is, in the common way of procuring it, generally one-seventh part of the weight of common air; and with the necessary precautions for philosophical experiments, less than one-tenth of the weight of common air. We shall conclude this article with a description of some figures explanatory of the subject. Figure 1 (plate Aerostation) represents a balloon, DF, suspended by means of the poles G and H, and the cord, for the purpose of being filled with gas. It is kept steady and held down whilst filling by ropes, which are readily disengaged. A, A, are two tubs, about three feet in diameter, and two feet deep, inverted in larger tubs, B, B, full of water. At the bottom of each of the inverted tubs there is a hole, to which is inserted a tin tube; to these the silken tubes of the balloon are tied. Each of the tubs, B, is surrounded by several strong casks, so regulated in number and capacity, as to be less than half full when the materials are equally distributed. In the top of these casks are two holes; to one of which is adapted a tin tube, formed so as to pass over the edge of the tub B, and through the water, and to terminate with its aperture under the inverted tub A. The other hole, which serves for supplying the cask with materials, is stopped with a wooden plug. When the balloon is to be filled, the common air is first to be expelled, then the silken tubes are fastened round the tin ones; the iron filings are to be put into the casks, then the water, and lastly the sulphuric acid. The balloon will speedily be inflated by the gas, and support itself without the aid of the rope GH. As the filling advances, a net is adjusted about it, the cords proceeding from the net are fastened to the hoop MN; the boat IK is suspended from the hoop, and whatever is wanted for the voyage is deposited in the boat. When the balloon is sufficiently full, the silken tubes are separated from the tin tubes, their extremities are tied, and they are placed in the boat. When the aeronauts are seated in the boat, the ropes that held the balloon down are slipped off, and the machine ascends in the air as in figure 2. In figure 3, is a representation of a part of Mr. Garnerin's balloon in its ascent, to which is attached the parachute in its contracted state, and below is the car. Figure 4 shews the manner in which Mr. Garnerin descended in the car by means of the expanded parachute, after he had detached it from the balloon. In figure 5 is represented an apparatus, as described by Mr. Cavallo, for filling balloons of the size of two or three feet in diameter with hydrogen gas, after passing it through water. A is a bottle with the ingredients; BCD a tube fastened in the neck at B, and passing through C, the cork of the other bottle, in which there is a hole made to receive the tube, and to this the balloon is tied. Thus the hydrogen gas, coming out of the tube D, will pass first through the water of the bottle E, and then into the balloon. Two small casks may be used instead of the bottles A and E.

ÆRVA, in botany, a genus of the Monadelphia Decandria class and order. The flowers are polyganous; the calyx five-leaved and patent: the stamina are five; the pistillum is a globulous ovary, having a filiform style, terminated by a bifid stigma: the fruit is an oblong, single-seeded capsule, encompassed by a calyx: there is but one species, viz. the Æ. ægyptiaca, or tomentosa, which grows on the sandy calcareous soil of Arabia.

ÆSCHYNOMENE, a word from the Greek, signifying *to be ashamed*, because it retreats from the touch: bastard sensitive plant, in botany, a genus of the Diadelphia Decandria class and order, and of the natural order of Papilio Naceæ, of which there are 12 species found native in the East Indies, and cultivated in other hot countries. One of the species may be treated as hemp, and is used for the same purposes.

AEROSTATION.



Lowry sculp

London. Published by Longman, Hurst, Rees & Orme, Feb.y 1. 1808.

AESCULUS, in botany, a genus of the Heptandria Monogynia class and order, of the natural order of Trihilatæ. There are three species: the first, or common horse-chestnut, was brought from the northern parts of Asia into Europe about the year 1550, and sent to Vienna about the year 1558. From Vienna it was conveyed to France and Italy; but it came to us from the Levant. It is distinguished by the beautiful parabolic form of its branches, the disposition and structure of its digitate leaves, and by the pyramidal bunches of its white flowers, variegated near the centre with yellow or red. Although this tree is now less in esteem for avenues and walks than it formerly was, on account of the early decay of its leaves, it affords an excellent shade; and the spikes of flowers which appear in May, with the intermixture of large leaves, exhibit a noble appearance. The most eligible situation for these trees is in lawns and parks, where they may be planted singly, and where their fruit will be serviceable to the deer, who are fond of it. This tree is of quick growth; and in a few years it will afford a good shade in summer, and yield plenty of flowers. Trees, raised from nuts, have in 12 or 14 years become large enough to shade two or three chairs with their branches, which in the season are covered with flowers. But the trees are of short duration, and the wood is of little value. It serves, however, for water-pipes, turner's ware, and fuel: and for these uses it is worth the charge of planting, and should be felled in November or December. The horse-chesnut has been employed in France and Switzerland for the purpose of bleaching yarn; and it is recommended in the Memoirs of the Society of Berne, Vol. II. part 2, as capable of extensive use in whitening not only flax and hemp, but silk and wool. It contains an astringent saponaceous juice, which is obtained by peeling the nuts, and grinding or rasping them. They are then mixed with hot rain or running water, in the proportion of 20 nuts to 10 or 12 quarts of water. Wove caps and stockings were milled in this water, and took the dye extremely well; and successful trials were made of it in fulling stuffs and cloths. Linen washed in this water takes a pleasing light sky-blue colour; and the filaments of hemp, steeped in it some days, were easily separated. The author of the memoir, above referred to, imagines, that if the meal of the chestnuts could be made into cakes or balls, it would answer the purposes of soap, in washing and fulling. The sediment, after infusion, loses its bitter taste, and becomes good food for fowls when mixed with bran. The Edinburgh College have admitted the horse-chestnut into their Pharmacopœia of 1783, on the recommendation of Dr. Gardiner, who says, that three or four grains of the powder snuffed up the nostrils in the evening, operate next morning as an excellent sternutatory, and thereby proves very beneficial in obstinate inflammations of the eyes. A patent was granted, in 1796, to Lord W. Murray, for his discovery of a method of extracting starch from horse-chestnuts.

The second species, or yellow-flowered horse-chestnut, is a native of North Carolina, was cultivated with us in 1764, and flowers in May and June.

The third species, or scarlet horse-chestnut, rises to the height of twenty feet, without much extending its branches; its bark is smooth, and the leaves, which are opposite, on long, red petioles, are of a light green.

The common horse-chestnut is propagated by sowing the nuts, after preserving them in sand during the winter: but the scarlet is propagated by grafting it upon stocks of the common horse-chestnut.

ÆTHUSA, in botany, a genus of the Pentandria Digynia class and order, and belonging to the natural order of Umbellatæ or Umbelliferæ: the calyx is an universal spreading umbel, and the partial is also spreading, but small; having no universal involucre, and the partial one placed on the outside, and consisting only of three very long, linear, pendulous leaflets, and the proper perianthium scarcely observable: the universal corolla is nearly uniform, with all the floscules fertile, and the partial has the petals bent in, heart-shaped, and unequal: the stamina are simple filaments, with roundish anthers; the pistillum is an inferior germ, and the styles are reflex, with obtuse stigmas: it has no pericarpium, and the fruit is roundish, streaked and bipartile: the seeds are two, roundish, streaked, except on a third part of the surface, which is plain. There are four species, the principal is Æ. cynapium, common fool's parsley, or lesser hemlock, which is a common weed in fields and kitchen-gardens, and in a slight degree poisonous. It is easily distinguished when in flower, in July and August, from true parsley and chervil, by the three narrow pendent leaflets of the involucre, placed on the outer part only of the umbel, and by its be-

ing a much humbler plant than either of the others. The leaves also, in an earlier state, are of a different form and a darker hue, and when bruised emit, in a slight degree, a disagreeable venomous smell. The safest way to avoid doubt or danger, is to cultivate the curled parsley. Most cattle eat it, but it is said to be noxious to geese.

ÆTIOLOGY, that branch of physic which assigns the causes of diseases; in this sense we say the ætiology of the small-pox, dropsy, &c.

ÆTIOLOGY, in rhetoric, is deemed a figure of speech, whereby, in relating an event, we, at the same time, unfold the causes of it.

ÆTNA, a famous volcanic or burning mountain in Sicily, situated on the eastern coast, not far from Catania. The height of this mountain is above 10,000 feet above the surface of the sea, and its circumference at the base is 180 miles. Over its sides are 77 cities, towns, and villages, the number of the inhabitants of which is about 115,000. From Catania to the summit is the distance of 30 miles, and the traveller must pass through three distinct climates, which may be denominated the torrid, the temperate, and the frigid. Accordingly, the whole mountain is divided into three distinct regions, called the fertile, the woody, and the barren. The first, or lowest region, extends through an interval of ascent from 12 to 18 miles. The city of Catania and several villages are situated in this first zone, and it abounds in pastures, orchards, and various kinds of fruit trees. Its great fertility is ascribed to the decomposition of lava, and of those vegetables, which have been introduced by the arts of agriculture, and the exertions of human industry. The figs and fruit in general, in this region, are reckoned the finest in Sicily. The lava of this region flows from a number of small mountains, which are dispersed over the immense declivity of Ætna. The woody region, or temperate zone, extends from 8 to 10 miles in a direct line, towards the top of the mountain; it comprehends a surface of about 40 or 45 square leagues. It forms a zone of the brightest green all around the mountain, which exhibits a pleasing contrast to the white and hoary head of the mountain. It is called the woody region, because it abounds with oaks, beeches, and firs. The soil is similar to that of the lower region. The air here is cool and refreshing, and every breeze is loaded with a thousand perfumes, the whole ground being covered over with the richest aromatic plants. Many parts of this region are the most heavenly spots upon earth; and if Ætna resemble hell within, it may with equal justice be said to resemble Paradise without. The upper region, called the frigid zone, is marked out by a circle of snow and ice. The surface of this zone is for the most part flat and even, and the approach to it is indicated by the decline of vegetation, by uncovered rocks of lava and heaps of sand, by near views of an expanse of snow and ice, and of torrents of smoke issuing from the crater of the mountain, and by the difficulty and danger of advancing amidst streams of melted snow, sheets of ice, and gusts of chilling wind. The curious traveller, however, thinks himself amply recompensed, upon gaining the summit, for the peril which he has encountered. At night the number of stars seem increased, and their light appears brighter than usual. The lustre of the milky-way is like a pure flame, that shoots across the heavens, and with the naked eye we may observe clusters of stars totally invisible in the lower regions. The scoriæ of which the mountain is composed have the same kind of base, containing shoerls and felt-spars.

AFFIDAVIT signifies an oath in writing, sworn before some person who is authorised to take the same.

In an affidavit, the time, place of habitation, and addition of the person who makes it, are to be inserted.

Affidavits are chiefly used to certify the serving of processes or other matters concerning the proceedings in a court; and therefore should set forth the matter of fact to be proved, without taking any notice of the merits of the cause. They are read in court upon motions, but are not admitted in evidence at trials.

By statute, the judges of the courts at Westminster may commission persons, in the several counties in England, to take affidavits relating to any thing depending in their several courts.

AFFINITY, among civilians, denotes the relation of each of the parties married to the kindred of the other.

Affinity is distinguished into three kinds. 1. Direct affinity, or that subsisting between the husband and his wife's relations by blood; or, between the wife and her husband's relations, by blood. 2. Secondary affinity, or that which subsists between the husband and his wife's relations, by marriage. 3. Collateral affinity, or that which

subsists between the husband and the relations of his wife's relations. The degrees of affinity are always the same with those of consanguinity. Hence, in whatever degree of consanguinity the kindred of one of the parties married are, they are in the same degree of affinity to the other.

By the canon law, direct affinity renders marriage unlawful to the fourth generation, inclusive; but the case is otherwise with respect to the secondary and collateral kinds. It is likewise to be observed, that the affinity contracted by a criminal commerce, is an impediment to marriage so far as the second generation: thus, a man is not allowed to marry the sister of a woman he has lain with. Nay, with regard to contracting marriage, affinity is not dissolved by death: for, though a woman may be admitted a witness for the brother of her deceased husband, she is not allowed to marry him.

Affinity, in chemistry, the attraction manifest between the part of bodies in chemical combination is, by many authors, distinguished by this name. See Chemistry.

AFFIRMATION, an indulgence allowed by law to the people called Quakers, who, in cases where an oath is required from others, may make a solemn affirmation that what they say is true. But their affirmation is confined to civil cases, and is not allowed in any criminal cause, nor with regard to places of profit or trust under the government.

AFFRAY, or Affrayment, in law, formerly signified the crime of affrighting other persons, by appearing in unusual armour, brandishing a weapon, &c. But, at present, affray denotes a skirmish or fighting between two or more: and there must be a stroke given, otherwise it is no affray.

AFFRONTEE, in heraldry, an appellation given to animals facing one another on an escutcheon, a kind of bearing, which is otherwise called *confrontée*, and stands opposed to *adossée*.

AFT, in the sea language, the same with abaft. See Abaft.

AFZELIA, in botany, a genus of the Didynamia Angiospermia class and order: the calyx is quinquepartite, the corolla campanulated, and the capsule rotundated with hemispheric receptacles. There is but one species, found in Africa, near the equinoctial.

AGAPANTHUS, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Liliacæ: the calyx is a spathe; the corolla is one petalled; the stamina are six filaments, inserted into the throat, shorter than the corolla; the anthers kidney-shaped and incumbent; the pistillum is a superior germ; the style filiform, of the length of three stamens; the stigma simple or trifid; the pericarpium is an oblong capsule; the seeds numerous, oblong, compressed, and enlarged with a membrane. There is one species, viz. A. umbellatus, or African blue lily. This is the African tuberose hyacinth with a blue umbellated flower. The root of this plant is composed of thick fleshy fibres; from the same head arises a cluster of leaves, which are thick and succulent; and of a dark green colour. Between these issues the flower stalk, supporting an umbel of blue flowers in a sheath, and each flower standing on a pedicle, about an inch long. The umbel being large, the flowers numerous, and of a light blue colour, make a fine appearance. They come out at the end of August, or beginning of September, and frequently continue in beauty till spring. It is a native of the Cape of Good Hope, from whence it was brought to Holland, and in 1692 it was cultivated at Hampton Court.

This plant is propagated by offsets, taken at the latter end of June, planted in separate pots, with light kitchen-garden earth, and placed in a shady situation. In five weeks the offsets will put off new roots, and the pots should then be removed to a more sunny situation, and have more water. In September they will put out their flower-stalks, and toward the end of the month the flowers will begin to open, and should be removed under shelter in bad weather, but in good weather exposed to the free air. Toward the end of October they should be removed to the green-house, and have the benefit of free air, and be occasionally watered during winter, in mild weather, but in frost they should be kept dry.

AGARIC, in botany, a genus of the order of Fungi, and class of Cryptogamia; the pileus or cap has gills underneath, and the gills differ in substance from the rest of the plant, being composed of two lamina, and the seeds are in the gills. There are nearly 400 species. Dr. Withering distributes them into three general classes, comprehending those which have central stems, those with lateral stems, and those which have no stems; and he again subdivides the two former classes into such as have solid, and such as have hollow stems, with decurrent, fixed, and loose gills respectively. Under these heads he arranges the species by the colour of the gills, into those whose

gills are white, brown, red, buff, yellow, grey, green, and purple. As this ingenious author has formed a system, that serves to facilitate the investigation and description of the several species of Agarics, we shall here give a brief sketch of the principles upon which it is founded. Agarics are composed of a cap or pileus, with gills underneath, and are either with or without stems. The stems are either central or lateral. They have also a root, which is more or less apparent, and some of them, in their unfolded state, wholly enclosed in a membranaceous or leather-like case, called a wrapper. Some of them have also a curtain, or thin membrane, extending from the stem to the edge of the pileus, which is rent as the pileus expands, and soon vanishes; but the part attached to the stem often remains, and forms round it a ring, which is more or less permanent, as its substance is more or less tender. Of all the species of Agaric, one only has been selected for cultivation in our gardens, viz. the A. campestris, or common mushroom, or champignon. The gills of this species are loose, pinky red, changing to a liver colour, in contact with the stem, but not united to it; very thick set, irregularly disposed, some forked next the stem, some next the edge of the pileus, some at both ends, and in that case generally excluding the intermediate smaller gills. The pileus is white, changing to brown when old, and becoming scurfy; regularly convex, fleshy, flatter with age, from two to four inches, and sometimes nine inches, in diameter, and liquefying in decay; the flesh white. The stem is solid, white, cylindrical, from two to three inches high, half an inch in diameter; the curtain white and delicate. When this mushroom first makes its appearance, it is smooth and almost globular; and in this state it is called a button. This species is esteemed the best and most savoury of the genus, and is much in request for the table in England. It is eaten fresh, either stewed or boiled, and preserved either as a pickle or in powder; and it furnishes the sauce called Catchup. The field plants are better for eating than those raised on artificial beds, their flesh being more tender; and those who are accustomed to them can distinguish them by their smell. But the cultivated ones are more sightly, may be more easily collected in the proper state for eating, and are firmer and better for pickling. The wild mushrooms are found in parks and other pastures, where the turf has not been ploughed up for many years; and the best time for gathering them is August and September.

AGATE, a fossil compounded of various substances, as chalcedony, cornelian, jasper, hornstone, quartz, &c. These different fossils do not all occur in every agate, commonly only two or three. There are different kinds of agate, as the fortification, the landscape, the ribbon, the moss, the tube, the clouded, the zoned, the star, the fragment, the punctuated, the petrefaction, the coral, and the jasper agate. No country affords finer agate, or in greater abundance, than Germany: it is found in great quantity at Oberstein, where several thousand persons are employed in quarrying, sorting, cutting, and polishing it. It is also found in France, England, Scotland, and Ireland, and very beautiful in the East Indies, where, however, it is confounded with onyx. It is cut into vases, mortars, snuff-boxes, and sometimes into plates for inlaying in tables. Very handsome specimens are made into seals, and the smaller pieces are used for gun flints. It was highly valued by the ancients, who executed many fine works in it: these, however, are only to be found in the cabinets of the rich. The collections of Brunswick and Dresdenar are remarkable for beautiful specimens of this kind.

AGATHOPHYLLUM, a genus of the Dodecandria Monogynia class and order: calyx very minute, truncate; petals six, inserted into the calyx; drupe somewhat globular; nut half five-celled, one-seeded; kernel five-lobed. One species, viz. A. aromaticum, a tree in Madagascar, with an aromatic rufous bark.

AGAVE, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Coronariæ: it has no calyx; the corolla is one-petalled and funnel-shaped; the stamina are filiform; the anthers linear; the pistillum is an oblong germen; the style filiform; the stigma headed and three-cornered, the pericarpium is oblong, and the seeds are numerous. There are seven species, of which we shall notice the A. Americana, or great American aloe, whose stems, when vigorous, rise upwards of twenty feet high, (one in the King of Prussia's garden rose to 40 feet,) and branch out on every side, so as to form a kind of pyramid, composed of greenish yellow flowers, which stand erect, and come out in thick clusters at every joint. The seeds do not come to maturity in England. When this plant flowers, it makes a beautiful appearance; and if it be protected from the

cold in autumn, a succession of new flowers will be produced for nearly three months, in favourable seasons. It has been a common error, that this plant does not flower till it is 100 years old: the truth is, that the flowering depends on its growth; so that in hot countries it will flower in a few years; but in colder climates the growth is slower, and it will be much longer before it shoots up a stem. The first that flowered in England is said to have been Mr. Cowell's, at Hoxton, in 1729, but they have occurred so often since that time, that they are now scarcely considered as rarities. Few of the variety with yellow-edged leaves have yet blossomed. There are hedges of the common agave in Spain, Portugal, Sicily, and Calabria; it flourishes also about Naples, and in other parts of Italy. The juice of the leaves, strained, and reduced to a thick consistence, by being exposed to the sun, may be made up into balls, by means of lye-ashes. It will lather with salt water, as well as fresh. The leaves, instead of passing between the rollers of a mill, may be pounded in a wooden mortar, and the juice brought to a consistence by the sun, or by boiling. A gallon of juice will yield about a pound of soft extract. The leaves are also used for scouring pewter, or other kitchen utensils, and floors. In Algarvia, where pasture is scarce, they are cut in thin transverse slices, and given to cattle. The inward substance of the decayed stalk will serve for tinder. The fibres of the leaves, separated by bruising and steeping in water, and afterwards beating them, will make a thread for common uses. Varieties of the common American agave, with gold and silver striped leaves, are not now uncommon in the English gardens. The Karatto agave is a variety brought from St. Christopher's, and the name is given to other species of this genus, and has leaves from 2½ to 3 feet long, and about 3 inches broad, ending in a black spine, and more erect than those of the others. This sort has not flowered in England. Linnæus has separated this genus from the aloe, because the stamina and style are extended much longer than the corolla, and the corolla rests upon the germ. Besides, all the agaves have their central leaves closely folding over each other, and embracing the flower-stem in the centre; so that these never flower till all the leaves are expanded, and when the flower is past the plants die. Whereas the flower-stem of the aloe is produced on one side of the centre, annually from the same plant, and the leaves are more expanded than in this genus.

AGE, in horsemanship, makes a considerable point of knowledge; the horse being an animal that remarkably shews the progress of his years, by correspondent alterations in his body. We have the chief characteristics from his teeth. The first year he has only small grinders and gatherers, of a brightish colour, which are called foal's teeth. The second year he changes his four foremost teeth, viz. two above and two below, and they appear browner and bigger than the rest. The third year he changes the teeth next these, leaving no apparent foal's teeth before, but two above, and two below, on each side, which are all bright and small. The fourth year he changes the teeth next these, and leaves no more foal's teeth before, but one above and below on each side. The fifth year his foremost teeth are all changed, and the tushes on each side are complete; and those which succeed the last foal's teeth are hollow, with a small black speck in the middle, which is called the mark in a horse's mouth, and continues till he is eight years old. The sixth year there appear new tushes, near which is visible some young flesh, at the bottom of the tush; the tushes being white, small, short, and sharp. The seventh year his teeth are at their full growth, and the mark in his mouth appears very plain. At eight all his teeth are full, plain, and smooth, and the black mark but just discernible; the tushes looking more yellow than ordinary. The ninth, his foremost teeth shew longer, broader, yellower, and fouler than before, the mark quite disappearing, and the tushes bluntish. At ten no holes are felt on the inside of the upper tushes, which, till then, are easily felt. At eleven his teeth are very long, yellow, black, and foul, and stand directly opposite each other. At twelve the teeth of his upper jaw hang over those of his under. At thirteen his tushes are worn almost close to his chaps, if he has been much ridden; otherwise they will be long, black, and foul.

Age likewise denotes certain periods of the duration of the world. Thus, among christian chronologers, we meet with the age of the law of nature, which comprehends the whole time between Adam and Moses; the age of the Jewish law, which takes in all the time from Moses to Christ; and lastly, the age of grace, or the number of years elapsed since the birth of Christ.

Among ancient historians, the duration of

the world is also subdivided into certain periods, called ages; of which they reckon three: the first, reaching from the creation to the deluge, which happened in Greece, during the reign of Ogyges, is called the obscure or uncertain age; the history of mankind, during that period, being altogether uncertain. The second, called the fabulous or heroic, terminates at the first olympiad; where the third, or historical age, commences.

The ancient poets also divided the duration of the world into four ages, or periods; the first of which they called the golden age, the second the silver age, the third the brazen age, the fourth the iron age. Not unlike these are the four ages of the world as computed by the East Indians, who extend them to a monstrous length.

Age, in law, signifies certain periods of life, when persons of both sexes are enabled to do certain acts, which for want of years and discretion they were incapable of before. Thus, a man at twelve years of age ought to take the oath of allegiance to the king, in a leet: at fourteen, which is his age of discretion, he may consent to marriage, choose his guardian, and claim his lands held in socage.

Twenty-one is called full age, a man or woman being then capable of acting for themselves, of managing their affairs, making contracts, disposing of their estates, and the like; which before that age they could not do. A woman is dowable at nine years of age, may consent to marry at twelve, and at fourteen choose her guardian, and at twenty-one may alienate her lands.

Age, in military affairs. A young man must be fourteen years of age, before he can become an officer in the line, or be entered as a cadet at Woolwich. Persons may be enlisted as soldiers from sixteen to forty-five; after the latter age every inhabitant is exempted from serving in the militia.

AGENT, in law, a person appointed to transact the business of another. It is a principle of law, that whenever a man has a power, as owner, to do a thing, he may, as consistent with his right, do it by deputy, either as agent, factor, or servant. If a person be appointed a general agent, the principal is bound by all his acts. But an agent, specially appointed cannot bind his principal by an act whereby he exceeds his authority.

AGERATUM, *maudlin*, in botany, a genus of the Syngenesia Polygamia Æqualis class of plants, with a monopetalous personated flower; and an oblong membranaceous fruit, divided into two cells, which contain a number of minute seeds, affixed to a placenta. There are two species.

AGGREGATE, in botany, is a term used to express those flowers which are composed of parts or florets, so united or incorporated by means either of the receptacle or calyx, that no one of them can be taken away without destroying the form of the whole. They are opposed to simple flowers, that have no such common part, which is either the receptacle or the calyx, and are usually divided into seven kinds, viz. the aggregate, properly so called, whose receptacle is dilated, and whose florets are supported by foot-stalks; such are the blue daisy, thrift, or sea-pink, &c.: the compound, which consist of several florets, that are placed, without partial peduncles, on a common dilated receptacle, and within a common perianthium; and where each floret hath its proper calyx; it is also a perianthium: umbellate, when the flower consists of many florets placed on fastigate peduncles, proceeding from the same stem or receptacle; and which, though of different lengths, rise to such a height as to form a regular head or umbel, flat, convex, or concave: cymous, when several fastigate peduncles proceed from the same centre, like the umbel, and rise to nearly an even height; but unlike the umbel, the secondary or partial peduncles proceed without any regular order, as in sambucus, viburnum, &c.: amentaceous, which have a long common receptacle, along these are disposed squamæ or scales, which form that sort of calyx called the Amentum: glumose, which proceed from a common husky calyx belonging to grasses, called Gluma, many of which flowers are placed on a common receptacle called Rachis, collecting the florets into the spike, as triticum, hordeum, bolium, &c.: and spadiceous, which have a common receptacle, protruded from within a common calyx, called Spatha, along which are disposed several florets. Such a receptacle is called a Spadix, and is either branched, as in phœnix; or simple, as in narcissus, &c. In this last case, the florets may be disposed all around it, as in calla, draconitum, &c.; on the lower part of it, as in arum, &c.; or on one side, as in zostera, &c. These flowers have generally no partial calyx.

Aggregate, in the Linnæan system of botany, is one of the natural methods of classing plants, and comprehending those which have aggregate flowers.

AGGREGATION, in chemistry, denotes the adhesion of parts of the same kind. Thus, pieces of sulphur united by fusion form an aggregate.

AGIO, in commerce, a term chiefly used in Holland and at Venice, where it denotes the difference between the value of bank stock and the current coin. Money in bank is commonly worth more than specie: thus, at Amsterdam, they give 103 or 104 florins for every 100 florins in bank. At Venice, the agio is fixed at 20 per cent. See EXCHANGE. Agio is also used for the profit arising from the discounting a note, bill, &c. Agio of assurance, is the same with what we call policy of assurance. See ASSURANCE.

AGREEMENT, in law, signifies the consent of several persons to any thing done or to be done.

There are three kinds of agreement: First, an agreement already executed at the beginning, as when money is paid, or other satisfaction made for the thing agreed to. Secondly, an agreement after an act done by another, to which a person agrees: this is also executed. Thirdly, an agreement executory, or to be executed in time to come.

An agreement put in writing does not change its nature, but if it be sealed and delivered, it becomes still stronger, nay, any writing under hand and seal, or a proviso amounting to an agreement, is equivalent to a covenant.

AGRICULTURE is the science which explains the means of making the earth produce, in plenty and perfection, those vegetables which are necessary to the subsistence or convenience of man. Its practice demands a considerable knowledge of the relations subsisting between the most important objects of nature. It is eminently conducive to the advantage of those actively engaged in it, by its tendency to promote their health, and to cherish in them a manly and ingenuous character; and every improvement made in the art must be considered as of high utility, as it facilitates the subsistence of a greater proportion of rational and moral agents; or, if we suppose the number to be unincreased, furnishes them with greater opportunities than could be possessed before, of obtaining that intellectual and moral enjoyment which is the most honourable characteristic of their nature. The strength of nations is in proportion to their skilful cultivation of the soil; and their independence is secured, and their patriotism animated, by obtaining from their native spot all the requisites for easy and vigorous subsistence.

Not only to raise vegetables for the use of man, but those animals also which are used for food, is obviously therefore part of the occupation of the husbandman; and to assist him in his operations, other animals are to be reared and fed by him, to relieve his labours by their strength and endurance of exertion. In cold and comparatively infertile climates the services of these creatures are particularly important, if not absolutely indispensable, and their health and multiplication become, consequently, objects of great and unremitted attention.

The period of the introduction of agriculture into Britain is unknown. Pliny observes that at the time of the Roman invasion, the inhabitants were acquainted with certain manures, particularly marl. During the possession of the island by the Romans, great quantities of grain were exported from it, and it cannot be doubted that, as in various other respects, the rude inhabitants derived advantage from their enlightened conquerors; they were eminently benefited by their agricultural experience. Amidst the series of contests and confusions which followed the final abandonment of Britain by the Romans, the art and practice of husbandry must be presumed to have become retrograde. From the Norman conquest, however, it derived fresh vigour, as a considerable number of Flemish farmers, by this revolution, became proprietors of British estates, and introduced that knowledge of the means of cultivation for which their own country had been long distinguished.

Before the sixteenth century few data are afforded with respect to the details of agricultural practice in this island. At this period it derived a valuable impulse from the exertions of Fitzherbert, a judge of the common pleas, whose treatises on the subject were read with avidity, and, while they abounded in instruction, excited a taste and emulation for the pursuits of husbandry. Sir Hugh Platt followed this path of genuine patriotism with great assiduity, modesty, and public advantage, treating particularly on the subject of manuring. Gabriel Plattes held out to his countrymen the light of genius, guided by experience. Capt. Blyth, in 1652, published a judicious treatise, containing directions for watering lands. And Hartlib, the friend of Millan, in a work called the Legacy, suggested the establishment of a national institution for the encouragement

of husbandry, and stimulated to the practice of it a number of country gentlemen, whom the violence and changes of the times had reduced to a situation in which they found it requisite to avail themselves of all means and resources to extricate themselves from comparative impoverishment. Evelyn and Jethro Tull were, at a somewhat later period, of eminent service in directing the attention of their contemporaries from the grossness and pollutions of voluptuousness, to this most valuable department of art; the former by his treatise on plants, the latter by his recommendation of the practice of drill husbandry. Since their successful and ingenious efforts, a series of valuable experimentalists and writers have performed to their country very essential service, by communicating the most useful information, and exciting a spirit of acute research and unwearied exertion.

In France the political expedience of guarding against that scarcity which, in time of war, either necessitated the yielding to harsh terms from the enemy, or exposed to the miseries and horrors of famine, by continued hostilities, induced the government, in the late reigns, to bestow on the subject of agriculture considerable attention, and to hold out numerous encouragements to it. The court was present at various experiments in husbandry. Prize questions were proposed at Lyons, Bourdeaux, and Amiens, for its promotion, and no less than fifteen societies for the express purpose of advancing agriculture were established with the approbation, probably at the suggestions, of the governing powers. But, notwithstanding all those efforts, which, however, can by no means be presumed to have been totally useless, French husbandry continued in a very deplorable state, ascribable in a great degree to that tenure of lands, by which through the greater part of the kingdom the landlord contributed the stock, and the occupier the labour; dividing the profits in certain proportioned shares. This circumstance, with several others, operated to keep the cultivation of this country in an extremely low state, and a comparative estimate of the produce of an English and of a French estate, of precisely similar natural advantages, at the period when this practice prevailed, would shew that, in consequence, principally, of so absurd and perverse a regulation, the superiority of the former to the latter was at least in the ratio of 36 to 25. But the revolution of France, changing every thing, has swept away, with many excellent individuals, and some valuable institutions, a practice so impolitic and injurious; and although our intercourse with that country, since this event, has scarcely been such as to afford accurate and detailed information of the present state of its husbandry, it cannot easily be doubted that the repeated transfers of landed property, the annihilation of partial burdens upon cultivation, the researches of ingenious chemists, and the general view of government to the productiveness of its territory, and to the promotion of its arts and sciences, must be connected with considerable improvement in this most valuable of national concerns.

In Germany lectures have for many years been given on this subject, in various states of it; and several princes in the empire, particularly the present King of Bavaria, have directed to it their particular attention and patronage. In Russia the late Empress gave it every facility which could be applied in the semibarbarous state of her dominions, and sent gentlemen into this and other countries, with a view to acquire information on rural economy, for the benefit of their own. In the Dutchy of Tuscany the Archduke Leopold recently diffused the active spirit of improvement by which he was himself animated, and an academy was endowed for the promotion of agriculture. A society for the same purpose was instituted about the year 1759 at Berne, in Switzerland, consisting of men of great political influence, and also of great personal experience in rural economics. The Stockholm Memoirs sufficiently evince that Sweden, under the influence of the great Linnæus, applied to this science with extraordinary success and advantage. Even the indolence and pride of Spain were roused to exertion on this interesting subject, and the government of that country made overtures to the Swedish Philosopher for the superintendance of a college directed to the advance of natural history and the art of husbandry.

In our own country, however, from a happy combination of circumstances, the exertions of individuals, societies, and government, have been directed, within the last thirty years, to the subject under consideration, with more energy and effect than have been displayed in any other part of Europe. The gentry and nobility have liberally patronized, and many of them judiciously and successfully practised it. The Royal Society, the Society of Arts, and various others, have been of distinguished

service in collecting and diffusing information, and in promoting a spirit of emulation, with respect to the management and productions of their native soil. The names of Kaims and Hunter, of Anderson and Marshall, of Sinclair and Young, are celebrated by publications, exhibiting a union of philosophical sagacity and patient experiment; the results of which have been of incalculable advantage; and to the efforts of these and other individuals, it may be ascribed that a board of agriculture was established by the government in 1793, whose exertions in procuring and publishing intelligence on the objects of its establishment have intitled it to the highest credit. By its agricultural surveys, by its diffusion of rewards for important discoveries, and of premiums for valuable treatises, and by its exertions at critical periods of scarcity, its utility and merit may be considered not only as decided, but distinguished. It has the power of directing public attention to any topics particularly requiring practical research or illustration, and possesses the means of most advantageously diffusing its collections, circumstances of high importance to the utility of the establishment. It must be regarded as its privilege as well as duty, to suggest, from time to time, to the legislature means for removing various impediments still existing to the perfection of the art, for the promotion of which it is expressly instituted.

ON INCLOSING AND DRAINING.

Inclosing of lands must be considered as the grand foundation of all improvements. When remaining open, litigations between neighbours are perpetually occurring, and the ingenuity of any individual proprietor is of little use to him, as he is obliged to follow the practice pursued by the ignorant and obstinate occupiers of the common property in which he shares. In connection with inclosures may be considered the practice of draining lands, which is the next step in rendering them productive. The superabundance of water is no less injurious to vegetation than the absolute want of it; and, whether arising from rain stagnating on the surface, or from springs in the interior of the earth, it is one of the most important objects of the farmer to prevent its pernicious consequences. For this purpose open or visible drains are in many cases adopted, while in others, hollow ones, so called from their being concealed in covered trenches are preferred. The width and depth of open drains must be regulated by the variety of soil, and situation to which they are applied. To prevent, however, the sides from falling in, they must at top be three times the width they have at bottom; while their direction must obviously, and of necessity, be descending, it should at the same time not be steep, as this would form inequalities, and bear down their sides by the rapid rush of the water. All open drains should be cleared, at least, once in every year; which regular repairs may, in some cases, render them in the end more expensive than those denominated hollow, which will sometimes last for several generations unimpaired, but demand originally a far greater sum for their completion.

The practice of hollow draining was known by the Roman writers on agriculture, and is particularly mentioned by them. In stiff clays it is of little service, and it is practised with desired effect only where the soil is of that porous substance which easily admits the passage of the water through it. Opinions differ with regard to the season for carrying these works into execution, some with plausible reason preferring the summer, and others having nearly as much to state in recommendation of winter for the purpose. The depth of the drain from the surface of the land should generally be from twenty-six inches to thirty-two; and the principal rule for their depth is, that they should be secured from receiving injury from the feet of horses or cattle ploughing on the spot under which they are made. It is desirable to constitute the drain in such a manner that the stones may lean towards each other, so as to form a triangle, of which the bottom of the drain forms the base; in which case the width of a foot may be regarded as sufficient for them. The ditches constructed for these drains must be executed with great neatness and care; and with respect to filling them up, which they should be about ten inches deep, if stones are plentifully at hand they should be applied for this purpose. But in many places faggot-wood, horns, bones, straw, fern, and even turf, laid in like a wedge, are all used in different situations, and drains constructed of these materials, thirty years ago, are found in several places effectually to answer their purpose still. By many persons, straw twisted into a very large rope, has been successfully laid in the bottom of the ditch; and by others, after twenty years experience, the white thorn has been recommended as answering better than all other materials.

Injurious moisture in land arises often from springs in the bowels of the earth. The person who first published the method of draining land in these circumstances, was Doctor John Anderson, of Aberdeen, while Mr. Elkington was actually practising upon the same principle, in various parts of England, with complete success; and at length obtained from the British parliament a thousand pounds, as the discoverer of so valuable an improvement. In Italy and in Germany, however, it is stated upon respectable authority, that the art has been long known and practised. Some of the strata of which the earth is composed, will admit the free passage of water through them, while others effectually resist it. Gravel is obviously characterised by the former quality, and clay by the latter. The upper part of mountains is frequently composed of gravel, which extends far into their depth, and conveys with it the water received upon their surface from the clouds. Meeting with layers of clay or rock, however, the water is unable to permeate them, and flows upon the upper part of them obliquely, according to that general direction of the layers or laminæ, which form the earth towards the plain or valley. After descending for some way, the layer of gravel along which the water had passed, and from which it could not penetrate the clay, flowing only on its surface, often passes, in consequence of the obliquity just mentioned, under new strata of materials, consisting of clay, or some substance equally difficult to be penetrated by moisture. The water is thus confined between impervious beds. If the layer of gravel suddenly stops, in such circumstances, as it often does, the water which it had conveyed between these two beds deriving fresh accumulation perpetually from its original source, will at length permeate the superior layer, ascending through its weaker parts, and arriving at last at the surface, will there stagnate. The art of draining lands in this situation, (the principle of which, in whatever research or casualty its discovery originated, is of such happy application) consists merely of digging or boring with an auger into the earth, so as to reach the layer of gravel; the water in which, finding an easy and rapid access upwards by this vent, no longer presses in its former diffused manner, to the injury of the superior clay, which will consequently cease to nourish moss and weeds, through redundant moisture, and be fitted for the purposes of useful cultivation. The application of this principle to the purposes of improved husbandry may be considered at present as in its infancy. It may be presumed that, in future periods, it may be carried to an extent of incalculable utility, and be connected with the supply of navigable canals, and the movement of machinery adapted to various objects of art and commerce. The manner in which the various strata are intermingled with each other, must, it is obvious, as nearly as possible, be ascertained before this practice can be applied with certainty of success; and the surest way of discovering their direction consists in examining the beds of the nearest rivers, and the appearance of their steep and broken banks. The examination of pits, wells, and quarries, in the vicinity, will also contribute information on the subject. Rushes and other plants, which grow only in moisture injurious to other vegetables, will likewise often indicate where a collection of water is impeded in its course below, and consequently presses upward, to the destruction of useful vegetation. In draining a large bog it will be generally proper to dig a trench from one end of it to the other, with cross trenches at considerable distances, to allow the water a free discharge, by frequently piercing the bottom, at which the springs are to be found, with an auger. A single perforation will frequently, indeed, complete the object. Instances have occurred in which water thus raised has been made to ascend, by erecting round the perforation a building of brick, lined on both sides with clay, above the level of the bog, applicable to a variety of purposes, and conveyed by pipes, or otherwise, to a considerable distance. Detailed regulations for the application of this important principle, so productive a source of improved cultivation, are precluded by the assigned limits of this article.

ON FENCES.

Without firm and close fences, the husbandman might as well cultivate open fields as inclosures, which in these circumstances, indeed, are only nominally such. He is under perpetual and well-founded apprehensions lest cattle of his own or his neighbours should break into his corn or hayfields. To prevent these painful apprehensions and irreparable mischiefs, every attention must be bestowed on the fences of a farm. Large and rich pastures may most easily be divided into fields of ten acres each, by which the land is less liable to be

injured through the restlessness and wild and perpetual movements of cattle, which occur in extensive grounds, where they are collected in considerable numbers. Dividing banks being raised, they may be connected with the system of draining by a ditch on each side, about three feet wide at top, and four deep. The bank or border should be about the width of six feet at the bottom, lessening gradually to three at the top, at which the height from the ground should be five or six feet. On each side of the bank should be planted a single row of quick-thorn. If the thorn be of the bullace or damson kind, it will be productive and profitable. On the top of the border filbert nuts may be planted, at distances of three feet; and, in the middle, apple-trees, at the distance of five feet. This fence would occupy about 13 feet, and, in the neighbourhood of London, particularly, would be found not only effectual for its main purpose, but a source of income as well as the means of defence. The hawthorn, the black thorn, and the holly, the willow, the black alder, and the birch, have all been recommended by observant and experienced men, as admirably calculated to secure fields from the irruptions of cattle, and will be employed for the purpose, according as particular circumstances of dryness or moisture, or other considerations recommend their application. Where there is an abundance of flat stones, fences are frequently composed of them; and, though not so agreeable to the eye as the others, and requiring frequent repair, from the stones being displaced by cattle, when kept in order they are the most effectual defence that can be procured. With respect to hedges, (which in this country are more usual as well as more pleasing than walls, and which, perhaps, cannot in general be formed of any thing preferable to the thorn, considering the quickness of its growth in congenial soil, in which it shoots six or seven feet in a single season, and that it is more disposed to lateral shoots than all other trees, and by its prickles is especially calculated for the object in view, in the construction of hedges,) the proper method of repairing them is unquestionably by plashing. This has been defined a wattling made of living wood. The old wood must, in the first instance, be all cleared from the hedge, together with brambles and irregularly growing stuff, and along the top of the bank should be left standing the straightest and best grown stems of thorn, hazel, elm, oak, or ash, about the number of six in a yard. The next step is to repair the ditch, which, in the driest soils, should never be less than three feet wide at top, by two and a half deep, and six inches wide at bottom; and in all very moist ones, should be at least four feet by three, and one at bottom. The earth removed from the ditch should be thrown upon the bank, after which the repair of the hedge commences, and those of the stems above mentioned, left in cutting the old hedge, which grow in the direction in which the new hedge is to run, are cut off to serve as hedge-stakes for it, which, being chosen as much as possible of sallow and willow, readily grow, and effectually preserve the new part from falling or leaning. The remainder of the wood left standing is then plashed down. One stroke is given to the stick near the ground, and another about ten or twelve inches higher, just deep enough to slit out a part of the wood between the two, leaving the stem supported by about a quarter of its original size; it is then laid along the top of the bank, and weaved among the hedge-stakes. Dead thorns are sometimes woven among them where there happens to be a scarcity of living wood. After this operation the hedge is eddered in the usual manner. The greatest part of the hedge thus consists of living materials, and the importance of this circumstance cannot be too strongly insisted upon, as a compact and lasting fence is thus formed, while those hedges which are constructed of dead materials speedily decay, and crumble into the ditch. It would be endless to detail all the varieties of fence which peculiar circumstances may have rendered expedient, or human ingenuity may have invented. The most usual and most generally applicable are those which have been mentioned.

IRRIGATION.

Watering of meadows was used in England even in the days of Queen Elizabeth, and was carried on upon a large scale by Rowland Vaughan, in the golden valley of Herefordshire. He likewise published a treatise on the subject. After this period, and about a century since, it was introduced by Mr. Welladvise into Gloucestershire with abundant proofs of its efficacy and importance. So slow, however, is the progress of improvement, that it is only of late years that this overflowing of grounds, in nearly all other situations as well as in level ones, has been brought considerably into

use. It is a practice by which, in mild seasons, grass is produced in extreme abundance, even so early as in March; grass, too, particularly nutritious as well as plentiful, on which cattle which have wintered hardly thrive with great rapidity, and on which young lambs feed with surprizing advantage. Between March and May, the feed of meadows, in consequence of this practice, is estimated at worth one guinea per acre; after which an acre will yield two tons of hay in June, while the after-math may be valued at twenty shillings. In consequence of this management, moreover, the land is continually improving in quality, its herbage advancing in fineness, the soil becoming more firm and sound, and the depth of its mould being augmented. It may be estimated, that in each county of England and Wales two thousand acres may be increased in value one pound per acre, by means of irrigation; a national advantage of serious moment, and drawing after it the great improvement of other lands, and the employment of many honest and industrious poor. The principles on which the practice depends have no portion of difficulty and complexity whatever. Water will always rise to the level of the receptacle from which it is derived. All streams descending in a greater or less degree, which is indicated by their smooth and slow, or their agitated and noisy progress, it is obvious that a main or trench may be taken from a river, which will convey water over the land by the side of that river to a considerable distance below the head of the main, where the river from which it is taken flows greatly below it. As water, however, if left to stagnate upon land, does it very considerable injury, instead of benefiting it, by cherishing flags, rushes, and other weeds, it is requisite to ascertain, before it be introduced upon any spot, that it can be easily and effectually drained off.

The muddiness of the water applied is stated by some to be of little consequence, and several writers have even laid it down as a maxim, that the purer or clearer the water is, the more beneficial are its effects. These opinions, however, appear to be directly contradicted by experience; and it may be affirmed, that the mud of water, particularly in some situations, is nearly of as much consequence in winter watering, as dung is in the improvement of a poor upland field. Every meadow will be found productive, proportionally to the quantity of mud collected from the water. Those meadows which lie next below any village or town, are uniformly most rapid and plentiful in their growth. So well known is this truth, that disputes are perpetually arising concerning the first application of water to lands; and when mud is supposed to be collected at the bottom of a river, or in ditches, many persons will employ labourers with rakes, for several days together, to disturb it, that it may be carried down by the water, and spread upon the meadows. The more turbid and feculent the water, the more beneficially it acts. Hasty and violent rains, producing floods, dissolve the salts of the circumjacent lands, and wash from them considerable portions of the manure which naturally or factitiously had been deposited on them. Water from a spring depends in no small degree for the quantity of nutriment it affords to vegetables on the nature of the strata over which it passes. If these be metallic, or consisting of earth partaking of the sulphuric acid, it may be really injurious. But that which passes over fossil chalks, or any thing of a calcareous nature, will highly promote the process of vegetation. That which has run a long way, is almost always preferable to what flows over land immediately from the spring.

In mid winter great attention should be applied to keeping watered land sheltered by the water from the rigour of night frosts: but during the whole winter it should be withdrawn once in every twelve days, to prevent its rotting and destroying the roots of the grass. Every meadow should also be attentively inspected, to preserve the equal distribution of the water over it, and to remove obstacles arising from the influx of weeds and sticks, and other similar causes. In the month of February particular caution is requisite. If the water be suffered to remain many days together upon the land, a white scum, extremely pernicious, is the consequence; and if the land be exposed, without drying during the course of the day, to one severe night frost, the herbage will often be completely cut off. Both these causes of injury must be carefully avoided. About the middle of February half the quantity of water previously used will be better than more, all that is requisite now being to keep the ground moist and warm, and to hasten the progress of vegetation; and in proportion as the weather becomes warmer, the quantity introduced should proportionally be diminished. An important maxim in the

application of water is to bring it on as plentifully as possible, but to let it pass off by a brisk and nimble course, as not only its stagnation is injurious, but by indolently creeping over the land it is of much less advantage than when passing off quickly. The spring feeding ought never to be done by heavier cattle than sheep or calves, as others would do extreme injury, by poaching the ground with their feet, and spoiling the trenches. The barer the meadows are fed towards the close of April, the better. After clearing, they should have a week's watering, with a careful attention to every sluice or drain.

With respect to the application of floods, a general rule of no slight importance is, that the farmer should avail himself of them whenever the grass cannot be used, as the sand and mud brought down by them increase and enrich the soil; but that he should avoid them when the grass is long or soon to be cut, as in flat countries it is frequently spoiled by them, and much of the matter which they bring down sticking to the grass, renders it peculiarly unpleasant to cattle, which have been known in some instances rather to starve than use it.

So great is the importance of irrigation, that governments would be fully justified in giving facility to undertakings for conducting it on an extensive plan. The fertility, or, in other words, the national wealth capable of being derived from the application of cold water, which is at present allowed to flow uselessly away, to the purposes of agriculture, is well worthy the attention of the enlightened and benevolent statesman. In the neighbourhood of the cities of Milan and Lodi, Mr. Young observes, that the exertions in irrigation are truly great, and even astonishing. "Canals are not only numerous and uninterrupted, but conducted with great skill and expense. Along the public roads, almost every where, there is one canal on the side of the road, and sometimes there are two. Cross ones are thrown over these on arches, and pass in trunks of brick or stone, under the road. A very considerable one, after passing for several miles by the side of the highway, sinks under it, and also under two other canals, carried in stone troughs a foot wide. The variety of directions in which the water is carried, the ease with which it is made to flow in opposite directions, and the obstacles which are overcome, are objects of admiration. The expense thus employed in the twenty miles from Milan to Lodi is immense; and meritorious as many undertakings in England are, they sink to nothing in comparison with these truly great and noble works. So well understood is the value of water in this country, that it is brought by the farmer (who has the power of conducting it through his neighbour's ground for a stipulated sum, and under certain regulations, to any distance that may suit him,) from a canal of a certain size, at so much an hour per week, and even from an hour down to a quarter. The usual price for an hour per week in perpetuity is fifteen hundred livres."

MANURES, &c.

Ingenious theories have too often, in agricultural treatises, usurped the place of recitals of attentive and patient experience. To the latter, the judicious reader will ever bend his attention with pleasure and advantage, rejoicing that while the systems of men are seen to vanish, one after another, in rapid succession, like the waves of the ocean, the course of nature is constant, and may be depended upon through all generations and ages. Of all the expenses incurred by the husbandman, none so rarely disappoints its object as that which he employs in manures. The use of lime in this connection has been long decidedly established. It reduces to mould all the dead roots of vegetables, with which the soil abounds. Its useful operation depends upon its intimate mixture with the land; and the proper time therefore to apply it is, when both are in that pulverized state in which this union can be best completed. If left to be slaked by humid air, or casual rain, it is seldom perfectly reduced to powder. The proper method is to place it in heaps on the ground on which it is intended to be spread, to slake it there with a due quantity of water, and afterwards to cover it with sod, to preserve it from the rain. If long slaked, however, before it is spread, it runs into clots, and becomes less operative for its purpose; besides which, it loses in such circumstances its caustic quality, on which account it should be brought home as short a time as possible before its intended application. Lime should not be permitted to lie all winter on the surface of the ground after being spread, for a similar reason, as also because it is washed down into the furrows; and on the sides of hills the whole is apt to be carried off by the winter torrents. It should be spread, and mixed with the soil immediately before sowing. The quantity to be laid on depends upon the

nature of the lands, which, if strong, will easily bear a hundred bolls per acre, while thin and gravelly ones will require only thirty or forty, and upon meadow ones fifty or sixty will be found sufficient.

Marl is valuable as a manure in proportion to the quantity of calcareous earth which it contains, which in some instances amounts to one half. When of this quality it may be regarded as the most substantial of all manures, converting the weakest ground nearly into the most productive. It is the best of manure for clay soils, in which all agricultural writers are perfectly agreed. Before its application, the land should be cleared of weeds, and smoothed, that it may be evenly spread; after which it should remain all winter on the surface. Its usefulness depends on its pulverization and close union with the soil to which it is applied. Frost, and a frequent alternation of dryness and humidity, contribute greatly to reduce it to powder, on which account it should, as much and as long as possible, be exposed to their influence. The proper season for marling land is summer. The best grain for the first crop after marl is oats. But, whatever be the crop, the furrow should be always ebbed, as otherwise the marl, which is a heavy body, sinks to the bottom of it.

Gypsum, or plaister of Paris, is commonly used in Switzerland and North America as a manure, and has been tried in this country with stated results of a very different description. Experiments, however, respecting its efficacy and advantages do not appear yet to have been made with sufficient accuracy to justify a final opinion respecting it. In Cornwall, and other counties, sea sand is laid upon the land in considerable quantities, and found extremely useful in softening stiff clays, and rendering them pervious to the roots of plants. Chalk, or powdered limestone, will also answer this important end; and sand, together with lime perfectly extinguished, will more effectually than any thing else open its texture, and prepare it for whatever is intended to be sown on it.

The true nourishment of vegetables consists of water, coal, salts, and different kinds of earths, which are ascertained to be the only substances common to vegetables, and the soils in which they grow. In favourable weather, grasses and corn absorb and perspire nearly half their weight of water every day. The great problem with respect to manuring or fertilizing a soil, appears to be, how to render coal soluble in water for the purposes of vegetation, and to discover that composition of the different earths which is best adapted to detain the due proportion of moisture. With respect to the former, the fermentation of dung appears to be the best method hitherto discovered; and as to the different kinds of earths to be applied for the improvement of particular soils, the experiments of Mr. Kirwan, to whom the world is indebted for much elaborate and ingenious analysis on the subject, have led him to several conclusions, which will be briefly noticed. Clay soils being defective in constitution and texture, want the calcareous ingredient, and coarse sand. The former is supplied by calcareous marl, and both are furnished by limestone gravel. Marl and dung are still more beneficial, as dung supplies the carbonaceous principle. Sand, chalk, or powdered limestone will either of them answer this purpose, though less advantageously. Coal ashes, chips of wood, burnt clay, brick-dust, and even pebbles, may be applied with this view. For clayey loam, if deficient in the calcareous ingredient, chalk is an excellent manure; if in the sandy ingredient, sand is the obvious and easy remedy: a deficiency in both will be best supplied by siliceous marl, limestone gravel, or effete lime with sand. The most effectual application for the chalky soils, which want both the argillaceous and the sandy ingredients, is clayey or sandy loams. For chalky loam, the best manure is clay, because this soil is chiefly defective in the argillaceous ingredient. Calcareous marl is the best manure for sandy soils. For sandy loams, chalk should be followed by clay; and for vitriolic soils, lime, or limestone gravel, or calcareous clay, is peculiarly applicable.

Not only sea-sand, but sea-weeds also may be employed to considerable advantage as manure. For lands on the coast it may be procured, not only in any quantities, but at a trifling expense. The weeds of rivers are also extremely useful for the same purpose. The refuse of slaughter-houses and oil cakes are well adapted to fertilize the soil, but in most situations not easily to be obtained at a reasonable rate.

In almost all circumstances the industry and ingenuity of the occupier must be depended upon for raising on the spot an adequate quantity of dung for its manure, and for this purpose it is expedient that, in such circumstances, as little as possible of the hay and straw raised upon the premises should be sold from them. This tenaciousness on the part of the farmer will

prove the constant source of improvement. With a view to turn his means of manure most advantageously to account, he should draw into his farm-yard, at the most leisurely season of the year, before the time of confining his cattle to fodder, as much marl, turf, dry mud, loam, and other applicable articles, as will cover its surface to the depth of twelve inches. If there be many hog-houses, stables, and cow-stalls, that are cleansed into the yard, on such spots these materials should be spread more thickly. Bog peats, if near at hand, should be never neglected. These peats may be regarded as vegetable dunghills, and their easy accessibility in this connexion will be regarded as of extreme utility and consequence. Before foddering is begun, the whole yard should be well littered, for which stubble, fern, and leaves, are well adapted. No money laid out by the farmer is more wisely and successfully expended than that which he employs in procuring, at a reasonable rate, great quantities of litter, by which his cattle are enabled to lie dry and warm, and the mass of manure which he raises is much larger and cheaper than he could procure in any other mode. Fern abounds in alkaline salts, and must therefore obviously produce very valuable dung: it requires, however, to be rotted well, and is more difficult to be so than straw. In woodlands leaves may be collected at slight expense, and will make admirable litter and dung. In the neighbourhood of marshes, rushes, flags, and coarse grass may all be easily procured, and will be exceedingly serviceable. After these exertions and preparations, the farmer must strictly confine his cattle during the winter, not by tying them, as some have done, but so as completely to prevent their roaming in the adjoining pastures. By thus confining all the cattle upon straw, and turnips, and hay, as may be requisite, the necessary quantity of animal manure will be obtained to make the compost of the several ingredients ferment, rot, and turn to rich manure, while without these animal materials the heap might be large, but would be of little value. The draining from the yard should never run towaste, and unless in extraordinary cases, such as extremely violent rains, this may be easily prevented. An excellent method for this purpose is the sinking a well in the lower part of the yard to fix a pump in; by which the water may be conveyed along a trough to a large heap of marl, turf, chalk, and other appropriate materials, which, by the daily application of this liquor will be of little less value eventually than a heap of dung of the same size.

If the dung remains under water, putrefaction is stopped; this therefore should be carefully guarded against. Stirring the dung should also be avoided, as the oils and alkaline salts are thus carried off into the atmosphere, and it is not merely rottenness that is wanted, and particularly that dry rottenness thus produced, but such as exhibits a fat, oily, mucelaginous appearance. It will be advisable, if practicable, to let it remain in the yard unmoved till the ground it is destined for is completely ready for its reception. If, for want of room in the yard, it must be carted off into the field, let the litter and the marl be well mixed in filling the cart, and let the whole form, under the shade of trees, if an opportunity be afforded for it, a heap about four feet in thickness.

The dung raised even by a few sheep in a standing fold, under a shed constructed expressly for the purpose, (for the trouble and expence of one composed of hurdles will overbalance its profits, unless upon a very large scale) is a considerable object, while the sheep under it are at the same time warm and comfortable, instead of being exposed to driving rains and snow.

Animal substances are very far preferable as manures to fossil or vegetable ones. Woollen rags, hog's hair, horn shavings, the offal of butcher's and fishmonger's stalls may be obtained in large cities, and whenever reasonably to be procured, should be eagerly caught at. With regard to the dung of animals, that of sheep is unquestionably the best. That of horses fed upon corn and hay is justly preferred to that of fatting cattle, which, however, is greatly superior to that of lean cattle, and particularly of cows, though they may feed upon turnips.

The practice of paring and burning is pronounced by men of great philosophical sagacity and research, and who have justly deferred more to practical results than to theoretical reasonings, to be of the most decided advantage in the preparation of land. It may be considered as a practice safe on any soil, as in some it is essentially necessary. That which most of all requires it, and which it is impossible by any other means to pulverize, is what consists of moss, rushes, and all kinds of coarse grass. It should be exercised on moor and heathfield, on account of the roots of the grass remaining in it, which are very stubborn and durable, and which check the growth of

corn, turnips, and other vegetables, by depriving them of a certain portion of nourishment. They serve likewise as a harbour for worms, the only effectual way to clear the ground from which is to burn it; the old and the young, together with their eggs, being thus destroyed or smothered. The ashes procured by paring and burning will furnish manure for several crops. The lessening of the soil by this husbandry was long apprehended; such a consequence, however, may be safely and positively denied, unless perhaps in cases in which the practice is carried to great excess. In poor soils, peat, and sedgy bottoms, the process is universally admitted to be a proper one. With respect even to clay lands; it produces not only the common manure found in vegetable ashes, but a substance which acts mechanically to the utmost advantage, loosening and opening the stubborn adhesion of the soil. In loam itself, the ploughing of rough pastures to the depth of eight or nine inches, and burning the whole furrow in heaps of about thirty bushels each, has been attended with most decided and durable improvement; and even though this depth be nearly twenty times the depth of common paring, the soil has not been supposed to be wasted eventually by the practice. Its texture has been rendered less stiff: the redundance of water has been expelled; and the immediate fertility attending this method of treatment fills it speedily with far more vegetable particles than it previously possessed. Sandy grounds are as improveable by this method as those of a different description, and chalk lands in every part of England have been so treated, and most profitably been brought into culture. In Gloucestershire, Yorkshire, and Lincolnshire; in Hampshire, Wiltshire, and Kent, the consequent crops of wheat, barley, oats, and sainfoin, have been of sufficient value to buy the land at more than forty years' purchase, at a fairly estimated rent before these improvements were applied. But whatever difference may exist with respect to the practice on such lands as have been just mentioned, and which is rapidly vanishing before obvious and impressive facts, no one, as already observed, doubts the propriety of it on peat. From the fens of Cambridgeshire to the bogs of Ireland, the moors of the north, or the sedgy bottoms abounding in almost every part of the united kingdom, paring and burning are universally employed, on their being broken up, by men of real experience and observation. The method of doing it by fallow is completely abandoned by all persons of this description, after the most regular and decided experiments of its results. In Cambridgeshire the work is performed by a plough, purposely constructed, and admirably adapted for it, which reduces the expense considerably. With respect to meadow and pasture land, it is performed by what is denominated a breast plough, which requiring great strength and labour in its application, much increases the cost. With regard to the general practice, it may be observed, that the heaps should not consist of more than twenty bushels, as, if they are much larger, the turfs will be too much burnt. Their size must be regulated in a great degree by the nature of the weather, and the thickness of the paring. When the ashes are spread, which should be completed as soon as possible, the land, as is usually the case, should be thinly ploughed. In almost all circumstances, the ashes should be left ploughed in for sowing turnips upon lands burnt in the months of March and April. If potatoes are desired, this preparation is excellently adapted to them, and they should be planted in April on lands burnt in March.

THE CULTURE OF GRASSES.

A close and sound turf may be considered as the best manure yet discovered, on which account it is justly remarked, that those who have grass can at any time have corn, the reverse of which is by no means true. Excellent grass lands therefore are valuable, not only directly, for the food of cattle, but indirectly, as containing ample means of raising grain, never failing, upon being broken up, to produce for a time a succession of valuable crops, whether of grain or roots. The small degree of labour and hazard attending the pasture of land, recommends it to many; and also the opportunity it supplies of laying out considerable property to great advantage in stock. Lands are preserved by it in good condition, and large estates may be managed under it with peculiar ease.

Grass lands, designed to be cut for hay, are to be distinguished from those on which the herbage is intended to be consumed by cattle upon the spot. In fields of the latter kind, properly called pastures, manure is supplied by the cattle; in the others it must be applied artificially, as large crops of hay exhaust the land, and always in proportion to the maturity which the herbage is suffered to attain before cropping, while nothing is

returned to the soil for all that is thus detached from it. In consequence, moreover, of depasturing lands, the plants, being unable to propagate themselves by seed, do it by root, forming a compact and matted turf, incapable of sending forth strong and powerful stems to form a good crop of hay, but abounding in slender and delicate shoots, such as the closeness of the turf will alone permit to pass, and which constitute a most nourishing and pleasing food for cattle. These two modes of employing land therefore should not be intermixed. What has for some time been applied to either purpose, should by all means be permitted to remain so; and to attempt to alternate the application of grass lands between pasture and cropping, is an effectual method of completely defeating both objects.

The difficulty of restoring old, rich, and clean pastures to their original state, after their being broken up, should ever prevent their being so, unless in very extraordinary cases. In common times they can be applied to no better purpose than their actual one: whenever it is expedient to direct them to the raising of grain, they will be certain to produce it in immense abundance.

With respect to the improvement of which grass lands are generally susceptible, those, of course, should in the first instance be applied to them which are connected with draining and inclosure, which happily coincide with each other, as the ditch serves at once for dividing and defending the land, and for clearing off the redundant moisture. Irrigation also, which, as well indeed as the last-mentioned topics, has been already adverted to, from its obvious and admirable utility to pasture, will derive every attention in this connection. In spring a heavy wooden roller should be applied, when the weather is moist, as it will then make the greater impression. The roots of the plants will thus be fixed in the soil. The mould will be crushed, and the worm-casts levelled, by this practice; and the ground is prepared by it for the application of the scythe, which will in consequence of this operation cut deeper, and with more facility.

The stocking of poor pastures with sheep, rather than black cattle, is of particular consequence to their improvement, and the perseverance in this practice for years, the sheep being folded upon the spot, has been more recruiting to poor soils than any other practice. A habit of matting its roots is given to the grass by the close bite of these animals, and a growth of delicate herbage is promoted. Weeds are likewise cleared by sheep, as every thing young and tender (even heath and broom) is readily eaten by them. By means also of the dung necessarily arising, an amelioration of the soil as well as produce takes place, of extreme and surprizing importance. The sweetness of the feed on the downs of Wiltshire arises, not so much from any natural and characteristic excellence of the grass grown on them, as from its being kept close, and eaten as rapidly as it vegetates. It has been remarked, that on certain poor soils it requires much more time to produce the second inch of vegetation than the first, making allowance for the fuller developement and size accompanying the second; a circumstance indicating that the preference should in such cases be given to the feeding by sheep rather than by cattle. The former remarks, however, on this subject, concerning the inapplicability of land thus depastured for rearing crops of hay, must never be forgotten.

Quicklime, spread in powder over the surface of pasture lands, will scarcely fail to improve, not only the poor, but the more valuable ones. The moss plants, which are so particularly pernicious, are thus destroyed, and converted into valuable manure. Upon impoverished and worn-out lands, about 270 bushels per acre on the sward, in summer, will be found of great and durable efficacy in cleaning and improving them. Mixing lime with earth taken from ditches or ponds is superior to using it alone, and, as a general rule, double the quantity of earth should be mixed with that of lime. The requisite proportions vary, however, with the nature of the soils; but are easily ascertained by attentive workmen.

Paring and burning may be applied to pasture with great success in a partial manner, by grubbing up rushes and bushes with which it may be encumbered, burning them after they are dried, and before the autumnal rains come on spreading their ashes on the surface. In some instances this husbandry may be successfully exercised on pasture over the whole surface, as particularly on a poor worn-out ley, which, by such a process, attended with the harrowing in of white clover and several other grass seeds, at the time of spreading the ashes, has been improved into very fine meadow. Where suitable, such a practice may be regarded as one of the cheapest of all improvements.

From whatever cause land may be overrun with moss plants, or covered with fern, rushes, and ant hills, it should be subjected

for some time to the plough, as no other method is equally useful to prepare for permanently ameliorating its pasture.

To prepare arable land for grass, it must be cleaned from weeds, and well manured, just in the same manner as that which is required for a crop of grain. Excepting upon stiff clays, the most eligible preparation for grass is a crop of turnips, consumed by cattle in the field: the ground being thus at once manured and cleaned. Where lands are broken up expressly for the purpose of improving the pasture, the turnips scarcely fail to succeed, through the manure afforded so abundantly by the fresh turf; and the cattle deriving from the abundant crop consequent on this circumstance a plentiful food, are thus enabled the more extensively to improve the soil by dung. On clay land the soil should be very liberally manured in spring or autumn, it ought to be ploughed once in autumn, and three or four times more in summer, previously to the period of sowing the seeds, which should take place in August. As to the much agitated question of sowing grass seeds with or without a crop of corn, it may be observed, that it is impossible for lands intended for grass crops, or meadow, to possess too high a state of richness, and that, after the soil is improved with a view to its permanent fertility in grass, to weaken it by a crop of corn appears little better than blind or infatuated counteraction. If, however, the practice be persevered in which has so generallybeen followed in this respect, barley should be the grain preferred, as springing up with a slight stalk, and not overshadowing and smothering the grass plants, and also as being the incumbrance to those plants more speedily removed than any other.

Whether grass seeds be sown in August after a fallow, or with corn in spring, all trampling by horses or cattle should be effectually prevented. Every thing therefore should be kept out from it both during autumn and winter. Not only is the tender soil, which is extremely susceptible of injury thus secured from it, but the pasturage in the spring is of proportionally more value for not having been eaten off in autumn, and affords a most valuable early bite for the ewes and lambs.

The proper treatment of leys during the first year is to feed them with sheep, unless, after a crop of hay be taken from them, vast quantities of manure be spread over their surface.

The chief food of cattle consisting of grasses, their importance is as obvious as it is great, and the distinguishing and selecting them cannot be too fully attended to. By this care the best grasses, and in the greatest abundance that the land admits of, are secured; while, for want of this attention, pastures are either filled with weeds, or bad and inappropriate grasses. The number of grasses fit, or at least necessary for the purposes of culture, is but small, scarcely exceeding half a score, and by the careful separation and sowing of the seeds of these, the husbandman would soon be enabled to accommodate the varieties of his soil, each with the herbage best adapted to it, the advantage of which would infinitely exceed the trouble necessary for its accomplishment. Were a great variety of grain to be sown in the same inclosure, the absurdity would be universally ridiculed; and scarcely less absurd and ridiculous is the common practice of indiscriminately sowing grass seeds from the foul hay rack, including a mixture of almost every species of grass seeds and rubbish.

The species of grass appropriated to any particular soil or application being determined upon, its seeds cannot be sown too plentifully, and no economy less deserving the name can possibly exist than the being sparing of grass seeds. The seeds of grain may easily be sown too thickly; but with respect to those of grass, it is scarcely capable of occurring. The smaller the stem, the more acceptable it is to cattle; and when the seeds, particularly of some grasses, are thinly scattered, their stems tend, as it is called, to wood.

The most valuable grass to be cut green for summer's food is red clover, which also is an admirable preparation for wheat. To have it in perfection, the weeds must be cleared, and the land harrowed as finely as possible. The surface should also be smoothed with a slight roller. The seeds should likewise be well covered with earth, as should all small seeds, notwithstanding the common opinion to the contrary. From the middle of April to that of May is the proper season for sowing it. Although it will last three years if cut down green, the safest course is to let it stand but one. It is luxuriant upon a rich soil, whether of clay, loam, or gravel, and will grow even upon a moor. For a wet soil it is totally unfit. It may be sown with grain with less impropriety than perhaps any other grass, and particularly with flax. When a land, left unploughed, spontaneously produces this plant, the soil may decidedly be pronounced good.

Those who lay down land permanently to grass, may best depend on white, or Dutch clover, for all rich and dry loams and sands, and for rich clays that have been properly drained.

Rye grass will flourish on any land but stiff clays. It is well adapted for permanent pasture, and if properly managed, is one of the best spring grasses. There are few so early, or more palatable and nutritive to cattle. It is less subject to injury in critical hay seasons than any other, and the seeds of none are collected with greater facility. It should be cut for hay some time previously to its being ripe, as the stalks will otherwise be converted into a species of straw, and its nutritive qualities be proportionably weakened.

Sainfoin is preferred by many agriculturists to clover, as less likely to injure cattle when they eat it green, producing larger crops, making better hay, and continuing four times longer in the ground. It is several years in arriving at its full strength. The quantity of milk yielded by means of it from cows is nearly double of what is produced by any other green food, and the quality also of the milk is proportionally better. It is much cultivated on chalky soils, and succeeds best where its roots run deep. Cold and wet clay is extremely ill adapted for it, and the dryness of land is of more consequence to its growth than even the richness of it. It is best cultivated by the drill husbandry, after repeated ploughing, harrowing, and rolling; and while care is taken not to leave the seeds uncovered, they must also not be buried deeper than about an inch. They should be sowed in the latter end of March. An acre of very ordinary land will maintain four cows for eight months, and afford the greatest part of their food in hay for the rest of the year.

Lucerne remains at least above twelve years producing very large crops, and yielding the most excellent hay, to the amount of about seven tons per acre. It has obtained the highest praises from all agricultural writers. With a view to its successful cultivation, the soil must be kept open and free from weeds, which is most effectually done by horse-hoing. It is transplanted with extreme advantage, if the tap root be cut off, by which it is fitted for a shallow soil, and its roots shoot out laterally and near the surface. The culture of this plant is a principal distinction of French husbandry, and is in that country a source of almost uniform profit. The best preparation for it is a turnip or cabbage crop. No manure should be allowed after the sowing till the crop is two years old. Its improving effect upon the soil is particularly great.

Burnet is a grass peculiarly adapted to poor land, and is so hardy, as to flourish when all other vegetation fails. Its cultivation is not hazardous or expensive. It is best sown in the beginning of July. It affords rich pleasant milk, and in great plenty. For moist loams and clays there cannot be a better grass than the meadow fox-tail, which is not only early, but remains for nine or ten years, and is little injured by frost.

To these remarks on a few of the grasses it may be added, that, in connection with soils, the principal grass plants have been thus arranged by one of the most distinguished agriculturists of the day:

Clay.	*Loam.*	*Sand.*
Cow grass	White clover	White clover
Cock's-foot	Rye	Rye
Dog's-tail	York white	York white
Fescue	Fescue	Yarrow
Fox-tail	Fox-tail	Burnet
Oat grass	Dog's-tail	Trefoil
Trefoil	Poa	Rib
York white	Timothy	
Timothy	Yarrow	
	Lucerne	

Chalk.	*Peat.*
Yarrow	White clover
Burnet	Dog's-tail
Trefoil	Cock's-foot
White clover	Rib
Sainfoin	York white
	Rye
	Fox-tail
	Fescue
	Timothy.

INSTRUMENTS AND OPERATIONS OF HUSBANDRY.

The instruments used in husbandry are so numerous, and, under the same denomination, often so differently constructed, with a view to varieties of the same operation, that it would be impossible in a sketch like the present to detail their structure and application. In the process for which they are respectively intended, every agriculturist will of course avail himself of those, the utility of which is best decided by experience.

PLOUGHING.

In almost all lands there is a fixed depth for the plough to go to, which is the stratum between the fertile and unfertile moulds

No soil should be ploughed beyond this bottom, or sole, which is the preservative on which the top layer should rest, and by which the manure laid upon the ground is prevented from losing its effect. In fallowing land, therefore, the plough may go as deep as the fertile soil will allow, as also in breaking up land without paring and burning. When land is pared and burnt, it ought to be ploughed in small furrows, and not so deep, as this depth of furrow would hazard the loss of the ashes for the immediate, and indeed for the subsequent crops. Where the sods are burnt in small heaps, and by slow fires, and the land ploughed shallow for the first time, and successively deeper and deeper, poor land will be more effectually benefited from itself than by any other mode; and in proportion as land can be made to maintain or improve itself, the benefit to the farmer is obvious.

Instead of ploughing stubble into the land, it is far better to mow the stubble, and even to harrow the land before it is fallowed. In soil of a poor quality, a certain proportion should be observed between the depth of ploughing and the quantity of manure usually spread, which on better soils might be safely disregarded. There are few which it is not requisite to plough to the depth of six inches, and for many the depth of ten is by no means too great. Once in twelve or eighteen months it is highly desirable to plough to the full depth, while in the interval shallower tillage will be preferable to deep working, for wheat particularly, which is best promoted by a firm bottom. A ploughing before harvest is of extreme consequence in fallowing, with respect to which seasonableness is of more consequence than the number of earths given. When fallows are called for, they should be attended with an observant eye, and be kept clean, whatever other business may press upon the husbandman's attention. On a well-managed farm servants and cattle will be kept sufficient for every necessary operation. The practice of fallows, however, is now abandoned in a variety of cases in which they were formerly deemed absolutely indispensable, and the well-informed agriculturist will seldom have recourse to them after his first year.

Harrowing is not only necessary for covering the seed, but also for preparing the land for its reception. The same instruments, whatever be their form, cannot answer the different purposes of this operation upon all soils, whether firm or loose, and rough or smooth. For every purpose, however, and of whatever size, they should be so constructed that no tooth can follow the track of another, and that every one should be constantly kept acting. The practice is best performed by harrowing a square piece of land at once, so that the instrument may be lifted at the corner, and the refuse stuff left there. The following harrows will thus have an opportunity of passing over every part of the land, and it will be completely cleaned from couch grass and all noxious weeds.

Till of late years the practice of rolling was but little used, or even known, and it is in many places exercised so slightly, as to be of little service. Its utility, when it is exercised as it ought to be, consists in rendering a loose soil more compact and solid, which, by making the earth adhere to the roots of plants, cherishes their growth. No roller that can be drawn by two, or even by four, horses will carry this effect too far. By rolling, moreover, the moisture of the earth is kept more in, and, in a dry season, this circumstance may reasonably be presumed sometimes to constitute the difference between a good and a bad crop. The common practice of breaking clods by means of mallets may judiciously be superseded by the roller, preceded for a day or two by harrowing. When firm and tough clay clods are to be broken, a large and heavy roller will be required for this purpose, with circles of iron of the depth of six or seven inches, which will completely reduce the most stubborn clods, and from its decided usefulness must by no means be regarded as a refinement in husbandry, productive of expense, without amply corresponding advantage. With respect to grass lands, the mowing for hay is extremely facilitated by the practice of rolling.

The practice of scarifying grass lands is used by a variety of persons, and is directly opposite to that of rolling them in its principle and effect. For this purpose a plough, consisting only of coulters, or narrow teeth, is employed; and it is asserted, that the crops of hay are considerably increased by the loosening of the earth occasioned by this process, the roots acquiring the power of fresh vegetation, while rolling is stated to increase the tenacity of many pastures in which it ought rather to be diminished. Previously to the manuring of grass land it is observed to be particularly beneficial, as whatever it be that is spread over the ground, finds, in consequence of this method, more rapid access to the roots, and a smaller quantity is remarked to answer the end pro-

posed than a considerable larger one without this practice. The operation may undoubtedly be beneficial in various instances and soils, and experiments indeed have evinced that it is so. The use of the roller, however, upon grass lands of a certain description will be admitted to be preferable; and with regard to arable land this new process by no means interferes with the application of the roller for all the purposes which have been mentioned.

DRILL HUSBANDRY.

The system of drill husbandry has been long known to be extremely preferable on sandy soils and dry loams, and in Norfolk particularly it made a rapid and extensive progress upon such lands. It has latterly been introduced on the strong soils of Suffolk. The objects of this husbandry are the promotion of the growth of plants by hoeing, and the saving of seed; objects it will be universally admitted of great importance. It was well known, that in gardens the hoeing and transplantation of vegetables often double their vigour: analogy therefore naturally led to the conclusion, that a similar result would occur from the same management of arable lands, and experience has decided both the practicability and the advantage of it. Land sowed with wheat, however well prepared and finished it may be in the autumn, sinks in winter, so that in the spring it possesses too great tenacity to admit the free extension of the roots for the collection of nourishment, and stands in extreme need of ploughing and hoeing to counteract these effects. Grain sown before winter therefore requires the process of hoeing inexpressibly more than what is sown in the spring; the land in the latter case not having had the same time to harden, nor to produce many weeds by exposure to the winter snow and rain.

As the vigour of the plants upon the drill system is very considerably increased, the land must be sowed much thinner than in the old practice; a circumstance which, in unreflecting minds, has operated as a considerable objection, it appearing at the first view, which on such is not only strong, but often indelibly impressive, that the vacant spots are completely lost or wasted. In the common practice, however, even in the most productive lands, the seeds, though very thickly sown, produce each but one or two ears, whereas two or three are universally produced by each in the latter mode, and sometimes a single one will produce 18 or 20. In the old method, there being by far more plants than nourishment, many must perish without attaining maturity, and many of the remainder can exist only in a languid and drooping state, whereas in the other method all have as much nutriment as they require, and, though comparatively few, being far more vigorous in their vegetation, they afford a larger produce than the numerous but sickly plants cultivated in the ordinary method.

For the application of this new mode, however, it is expedient that land should have been brought into good tilth by the old method, which being done, it should be so thinly sown as to leave sufficient room for the plants to extend themselves. It must be divided for this purpose into rows, 30 inches distant from each other, which will give an interval of two feet between the rows, every plant thereby having ample room to extend its roots and collect its food. In such considerable intervals, also, the earth may be hoed round the plants without the hazard of injury to them. The first hoeing should be applied when the wheat is in leaf, before winter, and is designed to draw off the wet and dispose the earth to be mellowed by frost. The second, after the hard frosts are passed, is calculated for making the plants branch freely. The third may be very slight, and should be given when the ears begin to appear. The last should be given when the wheat is in bloom, and is of the greatest importance, as it makes the ears fill at the extremities, and increases the size of the grain. In the middle of the intervals a deep furrow must be traced, and the earth be thrown to the right and left on the foot of the plants. By the careful application of the earth in this manner the plants are supported, and prevented from being laid, and the ground is prepared for the next sowing, in which the seed is to be put in the middle of the ground that formed the intervals.

The practice of hoeing may take place at almost any time in light and dry soils; but on strong and clay ones, in which the extremes of wet and dry are particularly inimical to vegetation, the seasons for its exercise are often short and critical.

As vigorous plants, such as are produced by this system, require a longer period for attaining maturity, the corn thus cultivated must be sown earlier than in the usual mode. The intervals are usually prepared for sowing again, by placing some well-rotted dung in the deep furrows made in the middle of them, and this dung must be covered by the

earth before thrown towards the rows of wheat. This should be performed immediately after harvest, that, before the rows are sowed, there may be time for slightly stirring the land. The intervals of the second year occupy the place taken up by the stubble of the preceding.

The banishment of the plough in spring, to as great a degree as possible, has taken place, in consequence of this most useful and happy innovation. All peas and beans, barley and oats, not only may be put in on an autumnal ploughing, but actually are so in many parts of the country (especially in Suffolk); the stiches in this ploughing being carefully thrown to the precise breadth suited to the intention of the farmer, whether to use only one movement of the drill, or what is usually denominated a bout of it; on which subject opinions differ. By the winter frosts a friability is given to the surface of the soil, so great, that very early in the spring, after one scarifying and harrowing, the corn may be drilled, and without a horse foot treading any where but in the stich furrows, where it can do no injury. Instead of losing this admirable gift of the atmosphere (which cannot be renewed), as was done by the former practice of at least two spring ploughings, it is thus completely preserved, and the delay, expense, and vexation occasioned to the farmer by the succession of rains and north-easterly winds, giving the dreadful alternative of mire and clods, are wholly avoided.

From a comparative estimate of the profits attending the different modes of husbandry, that of the new is stated, after various experiments, to be very nearly in the proportion of three to two: and making the utmost allowance for the influence by which the sanguine temperament of the partizan will interfere with the dispassionate calculations of philosophy, the advantage on the side of profit is indisputably and greatly with the modern system. It is also to be observed, that most of the accidents attending crops of wheat originate in their being late sown, which on the old plan is unavoidable; whereas in the new method the farmer may plough the furrows for the next crop as soon as ever the first is removed. The ground may be ploughed dry, and may be drilled wet. The seed, moreover, is not planted under the furrows, but at the precisely proper depth. The seed has all the advantage of early sowing, therefore, and the crop is more certain than by any other mode. The land also is much less exhausted by this method, the weeds being completely destroyed by the hoe, and none of the plants existing to draw nutriment from the ground but what attain their full maturity; whereas in the usual practice seeds are permitted inevitably to impoverish, and three-fourths of the plants themselves, after having derived a certain and a considerable portion of vegetable food from the soil, perish abortively. The state of the land, therefore, must necessarily and obviously be left far better by the new mode than by the old.

The practice of drill-husbandry has been justly remarked to be the management of the garden brought into the field; and the grand question relating to it is, whether the extraordinary expense of this finer cultivation be compensated by the superior quality or abundance of its crop? which the most sagacious and experienced judges have determined in the affirmative.

Even admitting, for a moment, after all, that the practice is not, on the whole, superior, or equal, to the old mode, its introduction has at least been highly serviceable in correcting and refining the old method of cultivation, and some of the reputation of the new one, may undoubtedly be allowed to have arisen from a comparison with slovenly and defective methods upon the old plan.

With regard to white crops, there are many practitioners of liberality and sense who reject this practice, although with respect to potatoes, cabbages, beans, and often turnips also, it is admitted by them to be unexceptionable. On a soil, however, in which the drill-machine can move with freedom, there appears no reason, and it may be almost said, no excuse, for the rejection of the modern system, which indeed, however recently it may have been introduced into this country, is practised in every part of China, and is used also by the inhabitants of the Carnatic, and, from the decided aversion of these nations to innovation, may naturally be supposed to have been their practice for a vast succession of ages. Tobacco, cotton, and the castor-oil plant are cultivated by it, as well as every species of grain.

THE CULTURE OF GRAIN AND ROOTS.

Of the various plants raised for the nourishment of man, wheat is of the chief importance. To prevent the disease so fatal to this vegetable, called the smut, steeping its seed for from twelve to twenty-four hours in a ley of wood ashes, in lime water, and in a solution of arsenic, is completely

efficacious, even although it should have been extremely affected by the disease. A less time is insufficient. On cold, wet, and backward soils the best season for putting this grain into the earth is September, particularly if the weather be rainy, as wheat should never be sown in a dry season. On dry and warm soils the sowing may be best postponed till October. In proportion to the earliness of the sowing a less quantity of seed is sufficient. The best preparation for it is by beans. Clover forms also an excellent preparation for it: and on a farm dry enough for turnips, and rich enough for wheat, the Norfolk practice of turnips, barley, clover, and wheat, is perhaps the most eligible that can be adopted.

By the dibbling of wheat, for a fortnight before which the land must be ploughed and rolled down with a heavy roller, the seed is deposited in the centre of the flag, and the regular treading which the land receives presses down the furrows, and gives it a most valuable degree of firmness. The chief attention required in dibbling is to make the holes deep enough, and to see that the children drop the seed equally, without scattering. After this dropping is completed, bush-harrowing follows. The quantity of seed should be about six pecks in two rows in a flag. If the drill-machine be used, the preparation of the land by ploughing, harrowing, and rolling must be extremely accurate, whether for one stroke of the machine, or for a bout of it, and the quantity of seed should be the same as that used in dibbling. In February, slight dressings are with great advantage spread over the green crop of this grain; and if the farmer has his choice for this purpose, he can never hesitate about taking them from dung; as dungs of all sorts are excellent, and no other manures, like these, are universally applicable. In the drill-husbandry the practice of hoeing is of the first importance, and has been already mentioned. If horse-hoeing be not employed, the hand-hoe may be used to great advantage, and should be performed first early in March, and the second time in the beginning of April. A scarifier is by many employed instead of the hoe, with the same object and effect. Whatever the operation, employed with this view, may be, the bottom should, with respect to wheat, be left firm and untouched. This is of particular importance.

A mild and open winter is far from being favourable to this grain, pushing it forward with too rapid vegetation, and also cherishing those weeds which become its most injurious enemies. No weather is so injurious to wheat in the ground as wet. If, however, it have a good blooming time, though the rest of the summer, both before and after this period, may be unkindly, little apprehension for the crop need be entertained from any state of the weather.

If wheat be attacked by mildew, which is most likely to occur in the month of July, the only effectual application is the sickle, which ought not to be delayed for a moment, though the ear be perfectly green.

Barley requires a mellow soil, and when sown upon clay, therefore, extraordinary care is required to stir the land immediately after the removal of the previous crop; and with this view the practice of rib-ploughing, which exposes the greatest possible quantity of surface to the air and frost, has been employed by many. This object should, at all events, be gained, whichever method be adopted for it, of the many which have been suggested, and are indeed practised. Scarification, with Mr. Cooke's machine for this purpose, instead of ploughing, is found to be an excellent method. In proportion to the tenaciousness of the soil must be the extent of this operation, which is easily dispatched, even when repeated, leaving the lands, or stiches, in excellent order for the drill-machine to advance and perfect its work.

The proper season for getting barley into the ground is March. The most useful preparation for it is by turnips. To have the land dry for sowing, is of more consequence for this grain, than it is for almost any other. It should always follow either an ameliorating crop or a fallow, and in many cases it should be followed by clover. The quantity of seed barley should be increased as the season advances, as early sown crops have more time to tiller than later ones: and in the same proportion the importance of the drill husbandry with regard to this article increases; as, if sown in the latter end of February in the broadcast method, it would get the start of weeds, which, if it be sown early in April, would extremely annoy it, according to the old mode, but by the hoeing practice may be easily removed.

Oats should never be sown after other corn crops (as the land is by this practice too much exhausted), and should receive the same preparation as barley; a circumstance often not sufficiently attended to.

Warm, forward sands yield as great a quantity of barley as of oats, and should, therefore, be applied to the culture of the former, as generally yielding a better price. Upon various other soils, however, the produce of oats will be in considerably greater proportion than that of barley, and by superior quantity more than compensate for being sold at the smaller price. To relieve the business of the succeeding months, oats may sometimes be sown in January; without this view, however, February is preferable. The land should have been ploughed in October. Six bushels per acre may be sown in broadcast, and on poor soils even eight to great advantage: the crop being by thick sowing several days sooner ripe, and the idea of saving seed with respect to this grain not being an object worth any particular attention. In the drill husbandry five bushels per acre are sufficient, and they should be horse-hoed early in the month of May.

Peas are extremely ameliorating to the soil, and may therefore, with very great advantage be substituted in tillage for white corn, a succession of which is peculiarly impoverishing. They should, however, not be sown on lands negligently prepared, as is too commonly done; and indeed the maxim cannot be too much attended to, with respect to grain, that none should be sown but on lands in really good order, with respect to heart, cleanness from weeds, and well-finished tilth. The uncertainty generally ascribed to this crop is to be attributed in a great degree to a neglect of these circumstances. At the same time, however, it is not meant to be asserted, that for all grain the preparation should be equally high and finished. The earlier peas are sown, the better they will thrive, and the more easily they will be moved off the ground in due time for turnips, a circumstance of particular importance. February is the proper month for their being sown. Early peas will seldom prove beneficial upon wet soils, and should be cultivated only on dry ones, upon sands, dry sandy loams, gravels, and chalks. The broadcast method should be most clearly rejected in relation to them. The only question is between drilling and dibbling them. On a ley, the latter practice cannot be too decidedly adopted. Put in on a layer, they do not want manure, which will often make them run to long straw, a circumstance unfavourable to podding, and likewise encourages weeds, which, in the infant stage of the growth of peas, cannot be extirpated without danger. If the land be in good heart, therefore, as it ought to be, dung may be applied with much more advantage to other crops; and being an article for which the farmer has, perhaps in all cases, a greater demand than he can supply, should be used with economy, and only where it is sure to answer best. The proper quantity of seeds to be applied in the drill-husbandry, in equally distant rows about one foot asunder, is seven pecks per acre. It is a judicious and valuable observation, the result of long experience, that peas should not be sown above once in about ten years, being not found to succeed if sown oftener.

Beans, where the land is proper for them, deserve from the farmer every attention, constituting one of the surest funds of profit. He is enabled by them to lessen, if not absolutely explode, the practice of fallowing. When cultivated, however, with a view of substituting them in the room of fallow, drilling or dibbling must be uniformly employed, so as to admit the plough between their rows, as no hand-work will sufficiently pulverize the lands for the purpose, without extreme expense. Dibbling, when well performed, with respect to beans, is an admirable method. The difficulty, however, of procuring it to be well done must be considered as no trifling objection to it. Beans are too often imperfectly delivered by the various drill-machines employed. On the other hand, however, the practice is less expensive than dibbling, and the seed is more surely put in to the desired depth, so that, on the whole, the drilling method seems preferable to that by dibbling. It is a point on which different circumstances will safely and judiciously lead to different conclusions, and soil, season, dependence upon servants, together with other considerations, will be resorted to, previously to the decision upon either of these methods. The common little horse-bean has the advantage of being more marketable than any other. Beans thrive upon light loams better than has been generally imagined. The soils, however, generally applied to their culture, are all the strong and heavy ones. Wherever they can be cultivated, the farmer ought to have them. They do not exhaust the soil. Wheat is prepared for by them, perhaps, better than by any other mode. They preserve their upright attitude to the latest period, admitting of horse-hoeing to the very last. The ground is well shaded by them from the sun; and,

if they are harvested favourably, their straw is valuable, and, at all events, may be converted into admirable dung. By a bad crop of peas, the land is often filled with weeds; but though a crop of beans should be extremely bad, the land may nevertheless be in the highest state of cleanness. The quantity of seed differs according to the variety of the grain. About two bushels of the horse-beans per acre, in rows equidistant, at eighteen inches, is a proper allowance, and February is the month in which they should be put in.

Buck-wheat is known to a vast majority of the farmers of this kingdom only by name. It has, however, numerous excellencies, is of an enriching nature, and prepares well for wheat, or any other crop. One bushel of seed is sufficient to sow an acre, which is only about the fourth part of the expense of seed barley. It is sold at the same price as barley, and is equal to it far the fatting of hogs and poultry. The end of May is the proper season for its being sown, and grass seeds may be sown with it, if the practice should be thought in any instance eligible, with more advantage than with any other grain, unless barley may be excepted. Buck-wheat may be sown even so late as the first week in July, a circumstance by which the period of tillage is considerably protracted, and an ameliorating crop may thus be produced, after the usual period has, from any unavoidable or casual occurrence, been neglected.

Potatoes form a most important article of food, both for the human species and for cattle, and are an inestimable substitute for bread formed of grain, the best resource in periods of scarcity of wheat; and, happily, when the crops of grain fail, through redundant moisture, the potatoe is far from being equally injured, and sometimes is even benefited by the wet season. The choice of soil for the culture of this root is of prime importance. Potatoes never make palatable nourishment for man if grown in a clay soil, or in rank, black loam, although in these circumstances they are well fitted for cattle, and relished by them, and also produced in great abundance. They grow to perfection for human food in gravelly and sandy soils. The drill should be universally preferred for their cultivation. In September, or October, the field intended for them should have successively a rousing furrow, a cross braking, and the operation of the cleaning harrow; and being formed into three-feet ridges, should remain in that state till April, which is the proper season for planting this root. After cross-braking them, to raise in a small degree the furrows, well-rotted horse-dung should be laid along them, on which the roots should be laid at eight inches distançe. The plough should then pass once round every row, to cover them. As soon as they appear above ground, the plough should be passed round them a second time, laying on the plants about an inch, or somewhat more, of mould, in addition. When they have attained the height of six inches, the plough should go twice along the middle of each interval, in opposite directions, laying earth first to one row, and then to another; and, to apply it more closely to the roots, a spade should afterwards be used to cover four inches of the plants, and bury all the weeds. The weeds which arise afterwards must be extirpated by the hand, as the hoes would go too deep, and damage the roots of the plants. From ten to fifteen bushels will be sufficient to plant an acre, the produce of which may probably be three hundred bushels. Sets should be cut for some few before they are planted, with at least one eye to each, and not in very small pieces, and the depredations of the grub upon them may be effectually prevented by scattering on the surface of the land about two bushels per acre of lime fresh slaked. The most certain method of taking them up, is to plough once round every row, at the distance of four inches, after which they may easily be raised, by a three-clawed fork, rather than by a spade, and scarcely a single one will by this practice be left in the ground. They may with care be preserved till the ensuing crop, particularly by the allowance necessary till April being closely covered in the barn with dry and pressed down straw, while the remainder for the ensuing part of the year is buried in a dry cave, mixed with the husks of dried oats, sand, or leaves, especially if a hay or corn-stack is erected over it.

Potatoes are subject to a disease called the curl, which has drawn the attention of sagacious and experienced men, and suggested, in consequence, a great variety of opinions on its cause and remedy. Some kinds of this root, however, it is almost unanimously agreed, are less susceptible of the disease than others, and the old red, the golden dun, and the long dun, are the least of all so. One or more of the following circumstances may be most probably considered as causing it; frost, insects, the planting from sets of unripe and large pota-

toes, the planting in old and exhausted grounds, and too near the surface, or the small shoots of the sets being broken off before planting. Where certainty on any interesting subject cannot be obtained, the hints of the judicious are always desirable. The methods most successfully exercised for the prevention of the curl, are, to cut the sets from smooth, ripe potatoes, of the middle size, which have been kept particularly dry, to guard against the rubbing off the first shoots, and to plant them rather deeply in fresh earth, with a mixture of quick lime.

No plant thrives better even in the coldest part of this island than the turnip, and none are more advantageous to the soil. Its introduction was an improvement of the most valuable nature. There is no soil which will not produce it, when previously prepared for it by art; but the gravelly one is best of all adapted to it. No root requires a finer mould than the turnip, and with a view to this object the land intended for it should be exposed to frost by ribbing it after the harvest. The season for sowing must be regulated by the time intended for feeding, the later from the first of June to the end of July, in proportion to the designed protraction of this feeding. The field should be first ploughed by a shallow furrow. Lime, if necessary, should be then harrowed into it. Single furrows, at the interval of three feet, should be drawn, and dung laid in them, which should be then covered by going round it with the plough, and forming the three-feet spaces into ridges. Wider rows answer no profitable object, and with straiter ones a horse has not room to walk. Thick sowing is far better than thin, bearing better the depredations of the fly, and forming also a protection against drought. The weeds may, in many cases, be most effectually extirpated by women, without injuring the crop; and the standing turnips should be left at twelve inches distance from each other. On average seasons, with good preparation, the produce from this number per acre may be considered as amounting to forty-six tons of valuable nourishment. For preservation, they may be stacked with straw; and forty-two tons may be thus secured by one load of straw, or of stubble and old haulm. A method preferred by many is that of sowing late crops, even in August, by which a succession of them remains on the field to be consumed on the spot, even so late as the ensuing May, and the advantage of having turnips good till the spring grasses are ready for food has greatly encouraged this practice. To prevent the devastations of the fly, the most destructive enemy to a crop of turnips, the most effectual method, as little dependance can be placed on steepings, or on fumigations, is to sow the seed at such a season that they may be well grown before the appearance of the insect; and by well dunging and manuring the ground, to hasten their attainment of the rough leaf in which the fly does not at all affect them. New seed, it may also be observed, vegetates more rapidly and vigorously than old; and the more healthy and vigorous the plants are, the more likely they are to escape depredation. The sowing of turnips with grain is by many recommended in this connection, and stated to be highly efficacious.

The culture of cabbages for cattle is a subject well meriting the attention of the agriculturist. The cabbage is subject to few diseases, and resists frost more easily than the turnip. It is palatable to cattle, and sooner fills them than carrots or potatoes; and, in every respect but one, cabbages are superior to turnips. On all soils they require manure; whereas, on good land, turnips may be raised without it. Fifty-four tons have been raised upon an acre of ground, not worth more than twelve shillings per annum. Some lands have produced sixty-eight. The time of setting them depends on their intended use. If for feeding in November, plants, procured from seed sown in the end of July in the former year, must be set in March or April; if for feeding in March, April, and May, they must be set in the beginning of the preceding July, from seed sown in the previous February. Repeated transplantation may be applied to them with singular advantage. When they are of the large species, four feet by two and a half are a full distance for them. The best protection for them from the caterpillar, by which these and greens in general are apt particularly to be injured, is to pull off the large under-leaves, (which may be given to cows with great benefit) on which the eggs of those insects are usually deposited. Sowing beans among the cabbages is also considered a most effectual preventive of the nuisance.

Carrots require a deeper soil than any other root, and when the soil does not naturally extend to the depth of twelve inches, equally good throughout, it must

be artificially made so for their culture, which may be easily effected by trench-ploughing. Loams and sandy soils are the *only ones* in which they will flourish, and no dung can be used for them in the year they are sown, as it will inevitably rot them. The ground must be prepared for them by the deepest possible furrows, and, when they are sown, about the beginning of April, it must be smoothed by a brake. In large plots of ground, where horse-hoeing is requisite, three feet should be the distance between the drills. Where an acre or a little more only is employed, the interval should not be greater than a foot, and hand-hoeing will be found more convenient, and scarcely attended with greater expense. From six to nine hundred bushels have been produced per acre of this root, where the land has been carefully prepared and attended to. As food for horses, its culture is rapidly spreading. For oxen, milch cows, and pigs, carrots are admirably applicable and nourishing, and, when boiled, turkeys and other poultry are fed on them with great success.

The ease with which parsnips are cultivated, and the great quantity of saccharine and nutritious matter which they contain, in which they are scarcely exceeded by any vegetable whatever, render them well worthy of the attention of the husbandman. Though little used in Britain, they are highly esteemed in many districts of France, in some parts being thought little inferior to wheat as food for man. Cows which are fed with them are stated to give as much milk as they do in the months of summer. All animals eat them with avidity, and in preference to potatoes, and fatten more quickly upon them. In the cultivation of them the seed should be sown in the autumn, immediately after it is reaped. When the seed is put in at this season, the plants will anticipate the growth of weeds in the following spring. Frost never does them any material injury. The best soil for them is a deep, rich loam. Sand is next suitable to them; and in a black, gritty soil they will flourish, but not in gravel or clay. In the deepest earth they are always largest. In an appropriate soil no manure is necessary for them, and a very good crop has been obtained for three years in succession, without using any. The seed should be sown in drills, at the distance of eighteen inches, for the greater convenience of hoeing; and by a second hoeing and a cautious earthing, by which the leaves may not be covered, the crop will be luxuriant. In Jersey, the root has been known and cultivated for several centuries, and is highly valued. It is considered as an excellent preparation for wheat, which, after parsnips, yields an abundant crop, without any manure.

The profit of cultivating hemp-seed is by no means small. It requires, however, the best land that can be found on a farm, or which is made such by manuring. A rich, deep, putrid, and friable loam, is what it particularly delights in; and in addition to natural richness, forty cubical yards of dung per acre should be applied. Besides this original cost of land in natural richness and preparation, it is to be considered that hemp returns nothing to the farm yard, while corn will give straw, and the dunghill is improved by green crops. The question concerning the propriety of its cultivation by any individual is not to be determined, therefore, only from the circumstance of any price in the market, but is to be inferred from a view of all its bearings and connections. For many crops, tillage should be given with caution. With hemp such caution is unnecessary, as its rank and luxuriant growth proves fatal to all those weeds by which corn would not only be injured, but destroyed. From the autumn preceding to the time of sowing hemp, the land should be three or four times ploughed, and be well harrowed to a fine surface. The quantity of dung should be proportioned to the deficiency of the soil; and when the culture is continued from year to year, a plentiful dressing must be every time applied. About twelve pecks should be sown per acre: and as the destruction of weeds in the tillage is here no object, the broadcast method is universally preferable to the drill. It will be ready for pulling in August, or about thirteen weeks after it is sown.

Flax, with due attention, will repay its cultivation; but, generally speaking, in this country the same land and manure may be more conveniently and profitably applied. Two bushels an acre is the requisite quantity of seed, and the land, if it be not particularly rich by nature, must be rendered so by art, must be worked to a fine surface, and be kept perfectly free from weeds.

The preparation for rape-seed is the same which is necessary for that of turnips. It is a crop subject to great injury, and extremely uncertain. In the conquered countries in the north of France, the practice is

to sow it in a seed bed for transplantation, which is begun in October, and if there be no frost in November, is continued through that month, when the plants are about two feet long. Were this operation to take place earlier, they would be more secure from the frost. Dibbling is employed for the purpose, and the plants are set at about the distance of eighteen inches by ten. In a favourable year the profit is considerable, as indeed it ought to be, to compensate for the frequent and inevitable failure attending this cultivation. An indispensable point in regard to this article, is to catch at opportunities of fine weather, for the purpose of reaping and threshing, which must be done in immediate succession. In reaping, extreme care is requisite, to prevent the shedding of the seed. Both in lifting it from the ground and conveying it to the barn floor, the utmost attention must be applied. As rain, at this critical period, may be considered nearly fatal to this produce, celerity of operation is of the first consequence, and as many assistants as possible should be procured, and not a moment of fine weather should be suffered to pass unimproved.

The cultivation of hops demands a greater capital than that of any other plant. The cost of the first year's preparation and planting will amount to about eighty pounds per acre, and the subsequent annual expense will be little less than half that sum; and after all the expense, preparation, and attention, which may be employed, no crop is more precarious. The serious consideration of a farmer is demanded, before he resolves to introduce this plant where it has not been usually cultivated. And not only the circumstances already mentioned, but that of the accessibility or distance of manure, (for which the largest quantities are called for by hops,) and the fact, that a small solitary hop ground seldom thrives like those which cover a large extent of country, from whatever cause this may proceed, should be fully weighed. Ruin may easily follow the want of adverting to these and other considerations, and they cannot therefore be too strongly impressed on the sanguine adventurer. A flat deep bog, in a sheltered situation, makes an excellent hop soil, constituting, indeed, a natural dunghill. For the application of such land to hops, the chances are favourable. The best preparation for this plant, when such a spot as this does not occur, is made by two successive crops of turnips or cabbages, fed off by sheep, early enough for the ploughing and planting in March. The plants should be inserted in rows, at eight feet distance from each other, and about six feet from hill to hill. Four fresh cuttings should be planted in each spot which is to form a hill. In April they should be poled, an operation requiring that critical accuracy, which, depending on changeable and casual circumstances, can be derived only from experience. The binds must next be tied to the poles. The superfluous vines must be pruned about Midsummer, and are a useful food for cows. September is the month for pulling them. But the management of hops is a subject most operose and delicate, requiring extreme experience, attention, and dexterity; and the details of which would, if extended only equally to its importance, occupy bulky volumes.

COURSE OF CROPS.

No subject of greater importance has been treated by modern writers in husbandry, than the succession of crops. Before the present reign, although a considerable number of writers on agriculture existed, this topic was little treated, and by many scarcely adverted to. It has at length obtained something approaching to that attention which it merits. The main principles upon which all practices on this subject proceed are, that some crops are more exhausting than others: that some, although of a very impoverishing character, yet by being consumed on the farm, return to it as much as they deducted originally from it, and, perhaps, even more: that some admit profitable tillage and accurate cleaning, during their growth; while by others the land is almost unavoidably rendered foul by weeds, is exhausted without return, and, when they are applied in succession, will be extremely and fatally impoverished. By experience much is found to depend on a certain arrangement of crops of these different and opposite characters; and in no one circumstance is the theory or practice of husbandry, in the present day, so materially advanced as in relation to this subject. Unless this department be well understood, the efforts of the farmer in others are either abortive or injurious. An important difference is observable between culmiferous and leguminous plants, or those which are cultivated for their seed, and such as are raised for their roots. The former bind the soil, while the latter uniformly give it openness and freedom. The former also are decidedly more exhausting, though unquestionably, in themselves, the most profitable. No soil

can bear them in long and uninterrupted succession. And, on the other hand, without the interposition of them among leguminous crops, the soil in which the latter grow would by their loosening quality become deficient in the tenacity which is necessary for vegetation. Some crops are rendered valuable chiefly from their preparation for others, that are more valuable, of a different kind. The husbandmen of a former age sowed frequently in succession that species of grain which they wished to possess abundantly: whereas, by this practice their object was often, at length, completely defeated. And if wheat, oats, or barley, were for a certain period sown in the same field, the land would eventually, and that in no long time, scarcely return the seed which was put into it.

That rotation is admitted to be best which enriches the land with abundant manure, preserves it best from weeds, pulverizes the soil most effectually when it is too tenacious, and binds it most completely where it is naturally too open. As a general rule, those who are engaged in agriculture cannot, with a view to these purposes, have the importance of providing food for large quantities of cattle too repeatedly and emphatically recommended to them. Indeed by attending to this circumstance, larger quantities of grain are produced than by any other mode, while that produce of the land which consists of milk, butter, cheese, butcher's meat, and other articles connected with cattle, is nearly so much clear gain. Grass prepares a turf, which when broken up constitutes the most valuable of all known manures. Turnips, cabbages, beans, peas, and a variety of other similar food for cattle, supply admirable opportunities for cleaning and pulverizing the soil by repeated hoeings; the close covering which they bestow on the land, smothers those weeds which the hoe does not destroy, and they leave the land, besides, in a state of increased and great fertility. Certain exceptions to the necessity of rearing cattle may undoubtedly occur, as, near towns and cities, the easy accessibility of dung will supersede very considerable preparation of it on the premises. Lands also may possibly be so rich as to require neither cattle nor sheep, and like some which are said to lie near the river Garonne, in France, might produce even hemp or wheat in perpetuity. Certain crops, moreover, may happen to be in such particular demand, as to make it desirable to cultivate them by fallow, and not for cattle or sheep. These exceptions can never interfere with the general rule as such, that that farm will be most productive and profitable, in respect to grain, on which is kept the greatest quantity of sheep and cattle. Two crops of white corn ought never to be produced from a field in immediate succession. In reference to several varieties of soil, it may be useful to give a succession of crops which has been recommended by a gentleman of considerable judgment and experience. It should be observed that on this plan the crops must be all particularly well hoed, and kept properly clean; and that the turnips, peas, and beans, must be put in double rows, on three feet ridges; the cabbages in single rows of three feet ridges.

Clay.	*Clayey-loams.*
Turnips or cabbages	Turnips or cabbages
Oats	Oats
Beans and clover	Clover
Wheat	Wheat
Turnips or cabbages	Turnips or cabbages
Oats	Barley
Beans and vetches	Beans
Wheat	Wheat

Rich loams and sandy loams.		*Peat earth.*	
Turnips & potatoes	Beans	Turnips	Turnips
Barley	Barley	Barley	Barley
Clover	Peas	Clover	Clover
Wheat	Wheat	Wheat	Wheat
Beans	*Ad infin.*	Potatoes	Potatoes
Barley		Barley	Barley
Peas		Peas	Peas
Wheat		Wheat	Wheat

Chalky substratum.	*Gravels.*	*Light lands.*
Turnips	Turnips	Turnips
Barley	Barley	Barley
Clover	Clover	Clover and rye-grass
Wheat	Wheat	Clover and rye-grass
Potatoes	Potatoes	Clover and rye-grass
Barley	Barley	Peas
Peas	Peas	Wheat or rye
Wheat	Wheat	

REAPING AND STORING.

In converting artificial grasses into hay the method should be different from that used with natural ones. They should for a day or two lie in swath, after which, being carefully turned, they should remain for a day or two longer: by which easy and simple process the hay is, in good weather, sufficiently made. After remaining two days in cocks, these should be carted to the stack.

With regard to the mowing of grass, in general, for hay, the workmen should be made to cut as low as possible, by which the crop is increased, and the remainder thrives better than it would do otherwise. Many hands should be ready to assist, and five makers are not too many for every mower. The grass should be shaken out immediately after the scythe. By the evening it should be raked into rows. The next morning it should be again shaken and spread, and in the evening it should be put up into cocks. These being opened on the following morning, after a similar process, may in fine weather be safely collected into the great hay cock at night. If successive rains come on to damage it, as it is stacked a peck of salt should be strewed in layers on every load, which will sweeten it and render it palatable for cattle, which would not taste it without this preparation. The stack should be covered within a week after it is finished, and a trench should be dug near it to carry off any wet, if it be placed in a situation subject to damp. The hard hay of a poor soil is little subject to firing, which often occurs with respect to that made of succulent herbage. The latter, therefore, requires longer time for its making. To preserve as much of the sap of grass as possible, without incurring the danger of firing, is the grand practical problem of hay making.

When the stems of culmiferous plants are totally divested of green, they are perfectly ripe. Some farmers recommend that wheat should be cut before this mature stage, not only to prevent any of the grain from shaking out, but as being found to make more excellent flour from being cut before perfect ripeness, than after having attained it. The latter observation may very safely be controverted. But, as it is admitted that every moment it remains standing after complete maturity, is critical, it may often be judicious to commence the reaping of it before the period of full ripeness. Wheat has been immemorially reaped instead of being mowed, and this method ought always to be adopted, as from its high growth it becomes untractable to the scythe. When barley ground is purposely smoothed by rolling, that crop may be cut down with the scythe, which not only, from the greater rapidity of its operation, removes that grain more effectually from the danger of being shaken by winds, but brings with it a much greater proportion of the straw for manure, than any other mode, a circumstance well deserving attention. Cutting of corn in wet weather ought ever to be avoided, if possible; and, however obvious this caution, it cannot be regarded as superfluous, as it is unfortunately very often neglected. Barley is particularly subject to injury by wet, having no protecting husk; and has a strong tendency, when cut in this state, to run to malting: it should not only be cut dry, but immediately, if possible, be bound up, to prevent its being discoloured, which will otherwise easily occur. Peas grow so irregularly as to make the sickle necessary. For removing the produce from the field, long carts, moveable upon the axle, by which the whole load is moved at once upon the ground, and lifted to the stack by persons appointed for the purpose, are preferable to other modes. Dispatch is thus obtained when particularly required, a circumstance always worthy of regard. Instead of housing corn, stacking it is a far superior practice, as it not only, by the consequent exposure to the air, carries what is called a finer countenance, but as it is more completely preserved from vermin than by being deposited in a barn. Every sheaf should be made to incline downward from its top to its bottom. Where they are laid horizontally, rain will be taken in both above and below. The best form for a stack is that of a cone, (the top of which should be formed with three sheaves united in a point) placed upon a cylinder. The moment a stack is finished the covering of it should, if possible, commence: materials should therefore be previously collected. If much rain should fall before this operation is performed, it will be difficult, and perhaps impossible, to render the stack dry while it stands; and in order to prevent putrefaction, it will be often requisite to pull it down, and after fully exposing every sheaf to the air, to reconstruct it.

The method of preserving potatoes has already been suggested, and to go farther into detail on this subject, would exceed our limits.

THRESHING.

The usual mode of threshing is attended with the inconvenience of the straw being very often not thoroughly cleared, by which much grain is lost; and with that of affording the workmen great and perpetual incentives to depredation, which, perhaps, are rarely resisted, or at least are certainly often yielded to. A fixed threshing mill will give comparative security against these evils; and one worked by two or three horses may be purchased for from sixty to

a hundred guineas, and which, in eight hours, will thresh fifteen quarters of wheat. The granary should be over this mill, and the corn may then, immediately after threshing, be drawn up into it and deposited safe under the key of the farmer. Fresh threshed straw is better than old for feeding cattle, and is best managed for them by being cut into chaff.

FRUIT TREES.

The culture of trees, for the purpose of deriving a fermented liquor from their juice, employs a great proportion of the land of this as of other countries; and is, therefore, an important branch of agricultural attention. The preparation of the juice of apples is more particularly attended to in the British empire, than of that of any other fruit; and the few remarks on the general subject which our limits will permit, will be confined to that fruit. The varieties of apples are entirely artificial, nature having produced only one species, which is the common crab. But different culture produces very great differences, which are preserved by artificial propagation. The seeds of the finest flavoured apples, among the native species, should be sown in seed beds, in an extremely rich soil; and the assistance of a frame, or even a stove, may be applied. In the first or second winter the plants should be removed to the nursery; while they remain there, the intervals between them may be occupied with garden stuff, which should not, however, crowd or overshadow them; and weeds, whenever they appear, should be extirpated. In pruning, particular attention must be given to the leader; and, where there are two, the weakest of them must be cut off. The undermost boughs should be gradually removed, and not all in one season. The height of the stem should be seven feet, or seven and a half, as the crops on a tree of this elevation are less exposed, and, indeed, the tree itself is less susceptible of injury. When they have attained five inches in girt, which they will do in seven or eight years, they may be safely planted out. Tillage is favourable, as the ground is thus stirred about them; and, where cattle are permitted to feed among them, they are apt to injure them, and, indeed, also to injure themselves after the trees begin to bear, by the fruit sticking in their throats; on which account apple grounds, not in tillage, should be eaten bare before the season of gathering. Apple trees should be carefully cleared of a redundance of wood, which intercepts the free circulation of the air. They should be kept clear also of the misletoe, which is often extremely injurious. Moss likewise should never be permitted to incumber them. The failure of crops, in particular years, is often ascribed to what is called blight; but, to adopt more intelligible language, is probably imputable to the great exhaustion of the trees by recent bearings; to prevent, or mitigate which exhaustion, the best application is that of care, to bestow upon them all the natural means of healthy and vigorous vegetation. Excess of bearing, however, will inevitably impair strength. Grafting in the boughs, and when they are fully grown thinning the branches, will prevent excessive produce, and may be considered as a very probable method of procuring fruit in moderate quantities every year. As general management, with respect to orchard grounds, it is a judicious rule to plant for such, a broken up worn out sward, keeping it under arable till the trees have attained tolerable growth, when it may with advantage be laid down to grass, and be permitted to remain in that state till the trees are finally removed. After one set of graftstocks on the stem have become effete, a second has been successfully applied: and thus, though the effect of age will at length prove fatal, the bearing of trees has been often very long protracted. The pear tree is of much longer duration than the apple. Both should be extirpated without reluctance, when their produce no longer compensates for the ground occupied by them.

TIMBER TREES AND COPPICES.

The planting of timber trees is an important aid to general cultivation, particularly in mountainous and moorish situations, where they afford shelter both for corn crops and cattle. Wherever plantations are formed in such situations, the aspect of the surrounding land is always improved, and exhibits a richer verdure. When suddenly removed, the contrary effect takes place; the efforts of human industry are then impaired; the warmth of the soil is dissipated; vegetation is pierced and chilled by the unresisted blasts which sweep along its surface; and the cattle are benumbed and stunted for want of protection from its fury.

In a flat and rich country, plantations often operate injuriously; and lofty hedge rows, containing stately trees, check the free passage of the air and light, prevent the seasonable drying of the ground, and, in a changeful and critical climate, the corn

is consequently delayed in its progress towards maturity, often cannot be gathered in proper condition, and, sometimes, is completely ruined. These considerations will generally be sufficient to decide the question of planting timber trees in particular situations. Where the practice is thought judicious with a view to the melioration of the soil, the larch, which is the quickest grower, and the most valuable of all the resinous trees, will be entitled to a preference. The most barren ground will answer all its demands for nourishment. For oak, better lands are indispensable. Beech trees under the protection of Scotch firs, previously planted for their shelter, will lay hold, eventually, even of a soil which possesses neither clay nor loam, and thrive so rapidly as to require, in a short period, that the firs should be cut down to afford freer air and ramification.

The use of small plantations of timber on large estates is very considerable. A vast quantity of posts, spars, and rafters, for buildings of every description on the farm, is perpetually called for in such circumstances, and will thus be fully supplied on the spot; whereas the want of it is attended with extreme expense and inconvenience. Planting should commence in October, and may be continued till April, excepting during frost. Injuries from cattle must be effectually guarded against in plantations, in their infant stage, which are as easily ruined as fields of corn. The fences, therefore, should be kept in the best possible repair.

With respect to coppices the caution about cattle is equally necessary. When coppices have attained the age of fourteen years, they may, generally speaking, be cut down more profitably than at any other age; and the most advantageous method after this, is to sort out the wood for appropriate purposes, whether for fuel, hoops, or hop poles; which arrangement will, in almost all cases furnishing such varieties, abundantly compensate for the time taken up in making it. In some situations, as in Surry for stakes and edders, in Gloucestershire for cordwood, in Yorkshire for railing, these articles yield a considerable advantage; and as they are sure of a market within a small distance, which with respect to the carriage of so bulky a commodity, is a point of the first consequence, an annual fall of wood applicable to these purposes may be desirable. The ground appropriated for its growth should be divided into that number of sowings or plantations, which will equal the number of years intended for their growth before cutting. The management will thus be easy as well as profitable, and fall naturally, without agitation and embarrassment, into the regular business of the year. These plantations may be sown either in October or March. The land being in good order, it should be sown with corn or pulse, appropriate to the season and the soil, after which the tree seeds should be put across the land in drills. Acorns and nuts must be dibbled, and the key berries scattered in trenches, drawn by the hoe, at four feet distance. Osiers may often be cultivated to great advantage, yielding a profit in the second, or at least in the third year; while a coppice requires 15 or 20, and an oak a 100 years to attain to its maturity.

CATTLE.

A considerable part of the stock of a farmer must always consist of cattle; and the maintenance and management of these, therefore, must ever be an object of great consequence; and in proportion to the number of them which he keeps for sale, in addition to those which he employs on account of their immediate service and labour, the importance of the subject is increased to him. Whether, in the latter point of view, oxen or horses are more advantageous has been a long agitated question. In situations in which there is a breed of cattle particularly adapted to work, and such situations do occur, the employment of the ox may probably be most beneficial. And when a farm is of so great extent that a considerable number of beasts may be annually bought at a small expense, and no inconvenience may be incurred by turning out those to fatten which are ill qualified for labour, the same preference may be wisely made. Bulls are on some accounts to be preferred to oxen, being procured at a cheaper rate, and more active and persevering in labour. In other cases than those just mentioned the question will be decided differently. The activity of the horse is extremely superior to that of oxen, and it is more applicable to different species of employment. Its hoof is less susceptible of injury; and, with respect to well managed farms, in which dispatch is more required than absolute strength in the operation of ploughing, the quickness with which the horse completes the business in comparison with the ox, will, it may be presumed, at length generally diffuse that preference of the one to the other, which is obviously in-

creasing every day. Yorkshire is the most distinguished part of England for the breed of horses, particularly for the saddle, and the black cart horse of the middle counties has been long celebrated. In the north of England, a very valuable breed from Lanarkshire in Scotland has lately been encouraged, of extreme activity, though not fit for particularly heavy draught, passing over a vast surface of land in a short time, and highly useful, therefore, not only in ploughing, but in the general work of a farm. The Norfolk management of horses, as instruments of agriculture, is considered by many as the cheapest that can be practised. In the winter months their sole rack meat is barley straw. In the most busy season a bushel of corn is thought an ample allowance, and the chaff of oats, which is far preferable to that of barley, is universally mixed with it. They are in summer kept out all night, and their feed is generally clover only. A great saving in the maintenance of horses has been obtained by the substitution of roots for grain. Turnips and potatoes have been given them in a raw state, in which case, if hard labour is required of them, some corn in addition may be expedient. If these roots are boiled, however, the corn may without injury be dispensed with. Carrots are better for horses than potatoes, and both are thought extremely serviceable in preventing various disorders to which they are subject, particularly the grease. Carrots are deemed an effectual cure for what is denominated thick wind in horses, and to broken winded ones, are of admirable use in palliating the complaint.

The practice of soiling horses, instead of turning them to grass in summer, is by many experienced men thought by far the superior method. The produce thus managed goes three times as far as if consumed in the field. The injury done by feeding pastures with horses instead of sheep or oxen, an injury very material and obvious, is avoided; and the dunghill, which, in all situations at a distance from towns and cities, is an invaluable object, especially if plentiful littering be allowed, is sufficiently benefited to compensate for this expense of their keeping.

Black cattle, intended for feeding, should be chosen for their being short legged, which quality is almost uniformly connected with a general good make. Straightness of back is another important recommendation, and the more perfectly straight they are, while at the same time they are very broad and flat on the loins, the more readily experienced judges will decide on their worth. Smallness of dewlap, and the barrel form of carcase, both in the fore and hind quarters, are also justly insisted upon as points of excellence. A curled hide is indicative of a thriving beast, and worthy of observation in the choice of these animals. A still more favourable symptom is a softness or sleekness of skin. Indeed the nice touch of the hand is requisite in the judge of cattle, perhaps nearly as much as the keen observation of the eye. Oxen that have been worked are more valuable to graziers than others, as not only fattening with greater rapidity, but furnishing more excellent beef. After working till the age of fourteen years, which is within two of the usual extent of their natural life, they have often supplied most tender and admirable meat.

It is a consideration of great importance to the grazier, that he should always secure such a stock of winter food for his cattle, as will maintain them during that season, reserving them for the spring market, which is always superior to that of autumn. From the beginning of March to that of June, the change of prices will be completely in his favour; and in order to avail himself of this, he must so arrange his affairs as to procure an adequate stock of winter maintenance. Whatever food is used for this purpose besides hay, the latter is always to be implied, and from seven to fourteen pounds a day should always be allowed to each beast. For hastening the process of fattening an ox, linseed cake has been found superior to every other article. Its price, however, of late years has been more than proportional to this advantage. Carrots complete their fatting with a nearly equal degree of celerity; and an ox will eat a sixth part of his weight of this root every day; at which rate an ox of sixty stone may be supported by the produce of an acre of these roots, for upwards of five months. Two beasts, of the weight just mentioned, if half fat when put to carrots, might become completely so by consuming the produce of an acre. Cabbages are but little inferior for the purpose to carrots and oil cake. An ox will eat of them nearly one fifth of his weight. Turnips are the most common description of winter food, but possess not the same fattening quality with the substances enumerated; and being a crop susceptible of various injuries, are much less to be relied on than many others. Of these the consumption of twenty-five ton is deemed necessary to fatten a beast of about sixty stone.

In consequence of eating succulent plants, and particularly clover, beasts are apt to swell greatly and very dangerously, in which case, driving them about with great rapidity is often practised with success, though a still more effectual method is to stab them between the ribs and hip bone to the depth of about four inches. A flexible tube has also been frequently passed through the mouth into the gullet, by which the air, which causes this disease, is easily discharged.

The practice of stall-feeding, or keeping the cattle in the house at every season of the year, and feeding them, when practicable, with green food, where there is abundant litter, is considered by excellent judges as the best method of turning to account the produce of the soil. Double the usual quantity of manure also is thus produced; and the annoyance of the cattle in any great degree by flies and insects is effectually precluded. This plan has been long and extensively practised in Germany, and is making its way in England, under the encouragement of many judicious agriculturists. Not only may grass be thus employed for food more profitably than in any other way, but boiled roots may be used with extreme advantage, with a view either to maintain or to fatten cattle; and, ridiculous as the idea of this management for a vast number of cattle and horses might at first appear, it is found capable of being performed with the aid of a steam engine by one superannuated attendant. The roots may be permitted to retain their original form, or may be mashed and converted into thick soup, as is deemed most eligible.

Cleanness and temperate warmth in the process of fattening beasts for human food are of the utmost importance; and it has been philosophically remarked, that analogy will lead us to conclude what observation justifies from fact, that whatever tends to form in beasts a state of feeling unirritated by fear, vexation, or pain, must tend to shorten the period necessary for advancing them to their maturity of size and excellence.

SHEEP.

Towards the end of August the annual purchase of wether lambs for an estate on which regular flocks are not kept generally takes place. These are justly preferred for stock to all others. The new Leicester have the advantage in competition with all the long-woolled breeds, and the SouthDown with all those of short or middling wools. For severe and mountainous moors, the black-faced and coarse-wooled Scotch sheep are by far to be preferred, being able to sustain the most rigorous weather, and to live on the most scanty food. Instead of putting sheep, after the above-mentioned purchases, to the highest feed, and pushing them to perfect fattening, the better way is to keep them tolerably well till March, and to begin then to fatten them, by which method they will be fit for sale at a season of more advanced price; and upon this plan the purchase money is, with good management, generally doubled, and the fleece found an additional clear advantage. Whatever be the nature of the stock, towards the middle of May they should be turned into their summer grass, and, in an inclosed farm, the division of the fields into different parcels intended to be fed is an object of great importance. It is justly thought, that in large parcels they do not thrive equally well as in small ones, and the waste of food is considerably greater. It will be found, that in flocks of from ten to twenty the same farm will keep considerably more than in one flock. The number should be appropriated to each field according to what it is enabled to carry, and suffered to remain, without any other change than what depends upon the state of individuals from accident or season. They will thus inevitably flourish. By adhering to the practice of folding, which, however, in certain cases may be necessary, much loss is often sustained; much food is spoiled; and injury arises from numbers being so closely crowded together: and although the practice may be highly beneficial, as preparative for corn, this advantage is often too dearly paid for. Another point of very considerable consequence with respect to sheep is the practice of close feeding. Even in pasturage shorn completely to the ground the herbage is found rapidly to spring up; and when drought is observed nearly to destroy the produce of fields treated in a different manner, by being permitted to run to bent, such as are managed in this close way are in comparison at least highly productive. In all plants cultivated for pasture the moment the seed stem runs, the grand effort of the system is directed to the formation of the seed, and the way to produce the greatest abundance of leaves, therefore, is to prevent the rising of these stems, which by close feeding is of course effectually accomplished.

In the whole range of husbandry perhaps the most perplexing point of management is the providing for flocks of sheep in the months of March and April. Turnips and hay are generally depended upon; but being frequently inadequate, rye is sometimes sown on purpose, and crops of wheat are also sometimes eaten down by them. All, however, is too frequently found insufficient, and they are permitted to run over the clover and pastures of the farm, committing great waste and damage. To prevent these evils, burnet should be cultivated by the farmer. It is a most hardy plant, and preserves its green leaves through the winter, and under deep snows vegetates with singular luxuriance. This will be an admirable feed for sheep in April, when turnips ought no longer to remain upon the ground. But kept grass on dry meadow and pasture, or what is called rouen, is preferable to every other dependance, and though consisting as it were of hay and grass in the same mouthful, being the autumnal growth at top sheltering the more recent vegetation beneath, the sheep eat both together without the slightest hesitation, and are found to thrive upon it extremely. Ten ewes, with their lambs, may be supported throughout April on one acre of this rouen, and no cheaper mode of keeping a full stock in April can possibly be adopted.

In June the washing of the sheep should generally take place, previously to the shearing. The washing may be best performed by a stream of water; and those who are engaged in it, instead of standing in the water, in which their uncomfortable situation leads them to hurry negligently over the business, should, by means of a cask or tub, be freed from such unpleasant and dangerous exposure. The shearing, which speedily follows this operation, should be as close as possible, and the circular is by far preferable to the longitudinal method with a view to this object.

Sheep that are kept in inclosures, and particularly in a woodland country, should be examined twice every day, to guard against injury to them from the fly, which in twenty-four hours after having struck sometimes produces incurable disease. The most efficacious treatment on this subject is, after parting the wool wherever the maggots are found, and picking them out with a knife, to scrape a small quantity of white lead among the wool, so that it may be carried evenly down to the wound. Regular and minute inspection will prevent such a circumstance as a broken coat in any of these animals, from a cause so dangerous and fatal where they are neglected.

When ewes are about to lamb, their keep should be of the most nourishing kind, consisting of plenty of turnips or cabbage. Till this period they may do without them. But all cattle that have young require as good keeping as those which are fatting. The turnips or cabbages should be drawn for them, and given them on dry ground. A standing rack of hay should be left for them on the field, which will be of great advantage to them.

SWINE.

The quick multiplication and growth of swine render them a species of stock highly profitable, and if reared systematically, and upon a large scale, none will be found to answer the purpose of the farmer better. Though supposed to be filthier than any other animals, they enjoy a clean and comfortable place for lying down in, and their thriving and feeding are at least as much improved by cleanly management as those of any other stock. Their styes should therefore be constructed sloping, to carry off all moisture. The different sorts of swine should be kept separate in them; and many should never be put together, and particularly if they be of different size. Too much attention cannot easily be paid to the rearing of these animals. The large Chinese breed is generally and justly preferred. When swine are reared on a comprehensive plan, crops must be sown purposely for their support, and the dairy cannot be considered as that resource which it is naturally regarded in small farms. From October till May potatoes, carrots, cabbages, and the Swedish turnip, which is a most useful vegetable for this particular purpose, must be provided for the swine and stores from October till the end of May, when they may be received into lucerne, chicory, or clover, on which they will be maintained till the clearing of the stubble; and thus, with the offal of the barn and the corn fields, and the plants and roots just mentioned, the whole year will be amply provided for. In summer meal must be mixed with water for the sows as they pig, and in winter boiled roots, peas, and oats should be given to the young ones. Dairy wash is a capital addition to this mixture. The sows should be permitted to pig but twice a year, in April and August. When great with pig, they must be carefully secluded from the boars,

and shut up about a fortnight beforehand in the stye; and while pigging, it is of extreme consequence that no one approaches them, or is even seen looking at them, as in this case they will often devour their farrow. After a week from this period, they should for a few hours in the day have the freedom of the yard, which will be a great relief from total confinement. Winter pigs, if not kept with great attention, are found less profitable than others. Milk and whey may so usefully be applied to them, that perhaps no other mode of their application is equally advantageous; and the best process for weaning them is by giving these articles to them mixed up with peas-soup, though the latter alone will answer well. When three or four months old, nothing is better for them than clover: turnips alone will not be proper, but corn should be added to them. Carrots and potatoes will keep them well till their full growth. Malt grains, if easily and cheaply to be procured, are highly to be recommended.

With a view to fattening hogs, the corn employed should be ground into meal, and in the proportion of five bushels to 100 gallons of water should be mixed in large cisterns: the mixture should for three weeks be well stirred every day, and at the end of that period will have fermented and become acid, before which it should not be given. A succession of vessels should be filled with this fermented food, that some may be always ready; and, before it is applied, it should be always stirred. Peas-soup is perhaps equally wholesome food with the above, and especially if made with warm milk. The preparation, however, is more expensive. Fatting hogs should be constantly well littered, and be kept perfectly clean.

POULTRY.

With respect to poultry, constituting as they generally do part of the stock, however small, upon farms, a few observations on them may not be thought superfluous. If kept merely for domestic supply, particular attention is needless. When reared with a view to profit, however, and on a somewhat large scale, they will repay, as they indeed require, considerable attention. A house should be erected for them, containing divisions appropriately for roosting, sitting, fatting, and food. The building should be constructed near the farm-yard, having clear water contiguous to it. Warmth and smoke are great cherishers of poultry. All, of every species, must have access to gravel and grass. Their cheapest food consists of boiled potatoes, on which it appears that they can be supported and fattened, without the aid of any corn. Where numbers of them are kept upon a farm, if permitted to go at large, they will often do considerable injury both in the fields and barn-yard, besides which they will be extremely exposed to the attacks of vermin, and will lose a considerable number of their eggs. A full-grown hen continues in her prime for three years, and may be supposed in that time to lay 200 eggs, which number, however, by warmth and nourishment, might be greatly exceeded.

The quality and size of the Norfolk turkeys are superior to those of any other part of the kingdom. They are fed almost entirely with buck-wheat, which, perhaps, may account for their excellence, and are bred by almost every little farmer in the county. When young, they demand perpetual attention, and must be fed with alum curds and chopped onions, and the expense attending their management and food can be compensated only where broods are tolerably successful, and the prices high.

THE DAIRY.

In the conduct of a dairy, which, in all but the most productive corn countries, is an object of particular consequence to the farmer, it is obviously of the first importance to select cows of the best sort, and in judging of the value of this animal, the best method of deciding it is by the quantity of cream produced in a given time, rather than of milk. The richest milk known is produced by cows of the Alderney breed; but, in all countries, cows yielding a very superior quantity of milk to the generality are to be found, and should be sought for by those persons to whom their produce is a particular object of attention; and the breed of such should be particularly cultivated. Rough waste lands, when the soil is wet, will do better for cows than sheep, and should be always appropriated to them, not indeed because they are the best for cows, but because no stock will so well pay upon them.

The grand object of keeping cows being the production of abundance and excellence of milk, they must, for this purpose, be supplied with food of the same description. About a month before they calve they should be taken from the straw-yard, and have green food given them twice a day,

with the roots, whatever they may happen to be, which have been raised for their winter food. Having calved, they should be kept perfectly separate from the lean stock, whether in the house or in another yard, and their food should be continued as before. Winter feeding cows with hay, even though none be given them before they calve, breaks in greatly upon the profits of the dairy. Cabbages will maintain them in the cheapest manner, and not give any unpleasant flavour to the milk and butter. The heart alone of the cabbage, however, should be given to them, and the refuse leaves be left to be picked up by the lean cattle. In the month of May they should be kept in particularly good feed, for which purpose they should be turned into the fields of clover, which had been early eaten off by sheep. Lucerne is, however, perhaps preferable to clover, as it is equally nourishing, and gives no ill flavour. When mown, and given in racks or cribs, it will go farther than in any other way, and yield an increased quantity of the most valuable manure, a circumstance which has been often insisted upon, and cannot be too frequently suggested. The feeding place should be kept extremely well littered. The profit of cows, in these circumstances, will be greater than turning them into luxuriant fields of these artificial grasses, although the quantity of their produce might by the latter method probably be increased; but by trampling upon and spoiling considerably more than they would eat, the little superior milk in richness or quantity which might be produced would be purchased at a most heavy expense, and one acre so managed would be requisite for every cow, while, by soiling, it would be amply sufficient for three. The clear profit in the comparison of any two modes of management is the grand point of the farmer's consideration, and whatever the farmer finds most profitable will eventually, it must be remembered, most benefit the public. Whatever green meat be thus used in soiling, should be fresh mown every two days, the quantity being, as nearly as may be adapted to the number to be so fed, not only of cows, but of other stock. Lucerne, if well managed, will bear four mowings for this purpose.

Cows should be milked three times a day, if fully fed, throughout the summer; and great caution should be exercised by the persons employed to draw the milk from them completely, not only to increase the quantity of produce, but to preserve its quality. Any portion which may be left in the udder seems gradually to be absorbed into the system, and no more is formed than enough to supply the loss of what is taken away, and by the continuance of the same mode a yet farther diminution of the secretion takes place, until at length scarcely any is produced. This mode of milking is always practised when it is intended that a cow should be rendered dry.

The apartments appropriated to dairy purposes should, if possible, possess a moderate temperature throughout the year, and should be kept perfectly clean and dry. The temperature of about fifty-five degrees is most favourable for the separation of the cream from the milk. The utensils of the dairy are best made of wood: lead and copper are soluble in acid, and highly pernicious; and though iron is not injurious, the taste of it might render the produce of the dairy unpalatable.

OBJECTS OF ATTENTION, WITH A VIEW TO THE SETTLEMENT AND SUCCESS OF A YOUNG AGRICULTURIST.

It is an object of extreme importance and difficulty to awaken due attention, without exciting useless anxiety. In selecting a situation in which to exercise the occupation of a farmer, various circumstances are minutely and deliberately to be regarded, and great consideration is required to form an accurate comparison of advantages and disadvantages. After these have been fully ascertained, a balance is to be drawn, and a decision to be made. More attention than time is requisite for this purpose, and hesitating, broken application will often occupy a longer period in arriving at an injudicious determination than, with persevering and dispassionate examination, is necessary to obtain a correct one. Headlong temerity, which diminishes, or even annihilates to the mind substantial evils, and minute, apprehensive prudence, by which every ant-hill of difficulty is made to swell into a mountain, are both to be carefully avoided; and a firm confidence in human exertion should unite on this critical occasion with keen and comprehensive observation. The soil is an object of particular consideration, in reference to a vast variety of circumstances; as to its stiffness and moisture, levelness or slope; its exposure or its stoniness; the manuring, draining, and fencing that may be required; the state of the roads; the accessibility of markets; the prices of manufactures, of produce, and labour; the custom of tithes; the

amount of poor rates; the compactness of the land, and the covenants concerning crops, are only a few of the points which demand in such circumstances to be duly ascertained and estimated. To fix on good land is a prudential general direction. For such it is not easy, with ordinary discretion, to pay too much, while for poor soils a small rent very frequently exceeds their worth.

The most advantageous of all soils are the mellow, putrid, crumbling, sandy loams: those which will admit tillage soon after rain, and, though finely harrowed, will not harden, as if baked, in consequence of the hottest sunshine, after violent rains. The stiff loam, which is very nearly approaching to proper brick earth, is, without plenty of manure, an unfavourable soil. On walking over it, it is found extremely adhesive in wet weather, and it requires a long time to dry. It may be considered as forming a medium between the clods of clay and the crumblings of loam. In stubble, a small green moss is frequently seen to cover it. By farmers, poverty and hunger are metaphorically, and most expressively applied to this land, which has a great number of varieties. It requires a large quantity of manure, and is wonderfully improved by hollow ditching. The expense of these operations must never be forgotten in connection with an estimate of their result.

Warm, dry, gravelly loams are, in winter, easily distinguishable. Unless in a particularly wet winter, they may be ploughed during almost any part of it, and will break up in a state of crumbling, running mould. A very bad soil is constantly formed by wet, cold gravel, which, in winter, is always indicated by its wetness, and in spring is known by the binding effects produced upon it by short and violent showers. It can be fertilized only by very extraordinary quantities of manure; and drains fully and neatly completed in it, will considerably improve it. Some gravels are of so particularly sharp and burning a nature, that, unless the summer be particularly wet, they will produce absolutely nothing. At any season this soil is obviously distinguishable. With respect to sands, the rich, red sand possesses always a dry soundness, and a temperate moisture, and will, in the driest summer, secure a crop. Its excellence and profitableness can scarcely be exceeded. Another admirable soil is formed of the light, sandy loam. It may be ploughed during the whole winter. The degree of its adhesion is precisely that of its perfection. It may be usefully observed, that when stiff land is dry and crumbling, it is a sure indication of its goodness, as the adhesive quality of a sandy soil is, with respect to that species of land, an equally decisive symptom in its favour. That which falls flat in powder is a mere barren sand. The chalk marle runs exceedingly to mortar from violent showers, after being pulverized, and is a cold and unprofitable soil. Clay land of great tenacity is usually let for more than it is worth; and, though it will yield abundance of wheat, is attended, in its management and preparation, with so great expense, that its profit is often trifling, and fortunes are far more frequently made by lands of a directly opposite description, consisting of light and dry sand. The common fault of stiff clays is wetness. Where fields are level, and, even though the furrows are well ploughed, the water stands in the land, the extreme tenacity of the soil is obvious. It is also broken up by the plough only by a very powerful draught of cattle, and in pieces of vast size and extreme hardness. In winter, soils approaching to this character are most to be distinguished. They will yield large crops of beans and wheat, but the sight of these should always be blended with the consideration of the immense expense at which they are necessarily raised. There are many variations of peat, bog, and fen, and all may be found exceedingly profitable; and if marl or lime be in the neighbourhood, that circumstance is a most important inducement to undertake the management of them.

With regard to grass lands they are to be best examined at several seasons, in order to ascertain their character. If they be too wet, this is shewn by walking over them in winter, and by rushes, flags, and moisture, which, in a greater or less degree, are always observable upon them. The grass is generally blue at the points, and always coarse. Draining may correct stiff loams, but the stiff tenacious clay is scarcely susceptible of cure. Grass, on gravelly soils, will inevitably burn in hot summers, but will extremely abound on loams in wet ones. On the banks of brooks and rivers, meadow of almost any soil may be considered good, but the circumstance of their liability to summer inundations ought never to be forgotten.

The herbage on many fields is sometimes composed of weeds and the coarsest and worst of grasses, which are at all times discernible, and indeed glaring. Under a pro-

hibition of arable, which is sometimes, and not unfrequently, the case, fields of this description are worth little or nothing. A river, well restrained within its banks, running through a farm, is a circumstance decidedly favourable. The grass-lands may thus be presumed to have water for the accommodation of cattle.

The quantity, as well as the nature of the soil, is likewise to be considered, and no larger quantity should be occupied than can conveniently be stocked. The bad management, and the perpetual embarrassment occurring in the contrary situation, are often ruinous to the health and to the fortunes of those who are involved in it.

The disjoined situation of the various fields of a farm, is a circumstance attended with great vexation and expense. Compactness of estates will always render them far more valuable; and opportunities of producing this compactness, by purchasing at a fair valuation, will never be neglected by vigilant and wealthy landlords.

To estimate the rent correctly, it has been judiciously recommended to connect it with tithes and poor rates. Whatever sum be intended to be invested in the farm, its interest may be fairly calculated at not less than ten per cent. A valuation of the expense and the produce should, for the next step, be carefully made; and after the former is deducted from the latter, what remains will be the sum which can be allowed for the demand of rent, in the three different forms above mentioned. If the amount of tithes and rates be deducted from this, what remains will be the sum which the occupier can afford to pay the landlord.

The nature of the covenants required, which are sometimes only absurd, and therefore admissible without difficulty, but sometimes equally absurd and mischievous, ought ever to be considered in connection not only with general but local and peculiar circumstances. The unreasonableness of the conditions proposed will sometimes be a valid objection to that occupancy which rent and situation, and all other circumstances might render highly eligible, and compensation in diminished rent will be necessary to indemnify for tying down the farmer from modes of cultivation uninjurious to the land, and inexpressibly the most beneficial to the occupier.

From three to five pounds per acre was, about forty years since, considered adequate to the stocking of any farm, partly grass and partly tillage, of the average fertility. The increase of rents and of rates, the higher composition for tithes, the advance upon all implements of husbandry, and upon every species of sheep and cattle, may be justly considered as having raised the sum necessary for the above purpose to seven or eight pounds. To form calculations upon this subject as accurately as possible, and ascertain that the requisite capital is possessed, for the due management of the land to be occupied, cannot be too emphatically insisted upon. The profit attending an increased expense in stocking will, in some cases, more than double the ratio of profit before that increase, and if the farmer be incapable of availing himself of striking opportunities for improvement, by the purchase of litter or of manure, and indeed by a variety of circumstances which may easily be suggested, for want of capital, his situation must be highly disadvantageous.

The choice of servants is a point requiring extreme attention. Where the assistance of a bailiff is required, as in all farms of very considerable extent, he should be of a somewhat superior description to those whom he must be authorized to command. The making of contracts and receiving money, which afford agents great temptation to dishonesty and to excess, should, whenever practicable, be performed by the principal. Of the inferior servants, the ploughmen are of most consequence, and skill and docility are their grand recommendations. It is desirable that all the servants should be under the master's eye. His constant superintendence will have great effect in promoting their sobriety and regularity, and not only will their permanent happiness be improved by this plan, a circumstance to a man of humanity of no light consideration, but their greater tractability and obedience will render the practice of this domesticating method in a selfish point of view, more useful to him, than that according to which, on many extended estates, the men and boys are all committed to the boarding and management of the bailiff. It may be considered as in general preferable to keep many servants and few day-labourers in the present times. The certainty of commanding hands at all seasons is an object of prime importance, and the difficulty of procuring additional ones when they are most wanted, is often upon the other plan insuperable.

It will be always eligible and expedient to pursue a *system* of management, comprehending every department of business

and expenses. The carelessness of profusion, and the sordidness of penury, must both be avoided with equal caution. A fixed sum, formed upon calculations, resulting from actual experiment, should be allotted for the expenses of the house, for personal expenses, for family dress, and other necessary demands, to be by no means exceeded, and as casual demands will always occur, a reserve should always be provided for contingencies. This methodical arrangement cannot be too strongly enforced on the young practitioner, who, without it, is in danger of inextricable confusion and ruin. If the investment on a farm be eight thousand pounds, after clearing all expenses arising from regular or contingent demands, and maintaining the establishment in liberal but accurate economy, if a hundred a year be not annually added to the occupier's capital, the concern must decidedly be a bad one. The addition of one hundred and fifty is very far from unreasonable. Whatever it be, in general it cannot be better employed than in prosecuting ascertained modes of improvement upon the farm, if it be the property of the occupier, or if he is in possession of a long lease.

Attendance at markets and fairs is an indispensable part of the farmer's occupation, but in a young man is attended with various temptations, such as sanguine and social temperaments find it difficult to resist. Caution, therefore, to such is perpetually requisite. Moreover, the society of persons in a superior style or rank in life, which, in consequence of establishments for agricultural improvement is easily accessible to the young man of vivacity and spirit, cannot be cherished without danger. His mind is thus alienated from his regular, and comparatively very laborious, and, as it may weakly be deemed, humble occupation, and fastidiousness, discontent, and neglect will usurp the place of tranquil and active industry. Such intercourses are completely beset with temptation, and have often induced imitation and profusion, neglected business, and eventual, and indeed speedy, destruction.

IMPEDIMENTS TO AGRICULTURAL IMPROVEMENTS.

The want of wise laws on this subject has ever been a serious obstacle. The produce of land, and the various manures which are necessary for fertilizing it, can be easily and cheaply conveyed only along good roads and navigable canals, and in proportion as a country is destitute of these, it is deficient in a grand source of national and agricultural prosperity. Arrangements on these topics cannot easily occupy too much of the attention, or at least meet with too much of the encouragement of the wise statesman. And as indefinite advantages might be derived from positive regulation on these and other details, in behalf of husbandry, much might also be done in many countries by the removal as well as by the enaction of laws. Where the husbandman is precluded from the best markets, the art of cultivation cannot possibly be pushed up to that point of maturity which it would otherwise acquire: the attainable perfection of this, as well as every other art, depending on the encouragement it finds, or in no less accurate, though perhaps more harsh and grating language, on the profit it produces. The most effectual mode of procuring the growth of any article in abundance is to insure it a reasonable price, and a rapid sale. Freedom of exportation from one country to another affords considerable facility for these, and promotes, therefore, the object which the blindness of former times supposed to be counteracted by it. Abundance is ascertained to be secured by the very means which the contracted policy of departed legislators imagined necessarily to defeat it. Such narrow views are, however, in general exploded. And though in countries where, as in Great Britain, the subsistence of the population is inadequately provided for by the natural produce, even in the best of seasons, there is less reason on this subject for complaint, than would operate in other circumstances, it is still an invariable and invaluable maxim, that no lands can be cultivated to their highest point of perfectibility, where restraints are permitted to operate on the disposal of their produce.

The operation of the tithe system must be considered as one of the most serious impediments on the subject under consideration. This odious and oppressive mode of providing for a class of persons, whose peculiar duty it is to polish the uncouthness of savage man, to inculcate on the world the principles of conciliation and kindness, furnishes a most singular dissonancy between the means and the end of those who instituted it; and its unmitigated continuance to the present day is a reflection on the sagacity, the energy, or the patriotism of the British legislature.

Regulations, by which those who have no share whatever in the expense of improvement should participate in its advantages, are not mere topics of theoretical absurdity, but attended with serious detriment in their operation throughout this country, in a moral, a religious, and, what is most of all to the present purpose, an agricultural point of view. With all the respect due to the representatives of a mighty empire, and with the most decided detachment from all points of vague and general innovation, this important subject cannot be too frequently presented to parliamentary attention. Human wisdom and human virtue will, it is hoped, be at length found equal to the correction of an absurdity at once so glaring and so prejudicial.

The want of due estimation of the occupation of husbandry, is in many countries a grand impediment to its progress. Where the cultivation of the soil is regarded with contempt, or as beneath the attention of men of rank and education, it will be entrusted to the management of persons of narrow capital and still narrower minds. Such prejudices operate in various places. They till lately existed to a great extent in France, and are yet deplorably prevalent in Spain. In England, fortunately, they are every day rapidly dissipating. Agriculture is ascertained to be the road to wealth and respectability; and men of high connections and distinguished fortunes, think themselves honoured instead of being degraded, by a regular and assiduous application to it, and by establishing their sons in situations, in which they may look to it as the means of maintaining families, accumulating property, and doing service and honour to their country.

Agriculture is very injuriously checked by the occupier of land not possessing in it a requisite interest. Even in this country, large portions of land are held by communities of persons, the individuals of which, have no right to any particular spot of it, and are not only thus precluded from personal and active cultivation, but by the scanty right and profit which they possess in the general property, possess no sufficient motive to enforce correct management and improving cultivation on those persons by whom it is actually occupied. Family entails and short leases are likewise eminently hostile to full cultivation, upon the obvious principle, that men will ever apply their capital and exertions only in proportion to their expectation of advantage. Even when leases are granted of a reasonable number of years, restrictive clauses are too frequently introduced, by which the progress of improvement is arrested, and a mode of cultivation insisted upon contrary to the views and the interest of the occupier, and not by any means more beneficial to the owner, than what was designed to be adopted, often inexpressibly less so. Prejudice and caprice in the proprietor are often substituted for the judgment of experience; and a routine of practice compelled upon the cultivator, in consequence of which, curious research and attentive experiment are rendered nearly superfluous. Superior knowledge, which would in these circumstances be almost useless, ceases to be sought for, and stupid acquiescence is substituted for lively observation. It is however of importance, that towards the close of a term, the series of cropping should be regulated by covenant, as the inducement to exhaust land, to the extreme injury of the owner and the public would otherwise be seldom resisted. Beyond this object it is unwise to enforce restriction or to yield to it, and whatever discoveries are made by the personal experience of the farmer himself, or are derived from the experience and practice of others, it is desirable that he should ever be free to avail himself of them. The liberal ideas on this subject, which have been suggested by the best writers, and adopted by enlightened landlords, will unquestionably in time, and it is hoped rapidly, prevail to the almost total exclusion of those narrow and pernicious notions which have hitherto existed.

It is desirable that the farmer should occupy a sufficient tract of land to engage his time, not irregularly and occasionally, but fully and completely, by which means his attention is not distracted from this important employment to others which would interfere with it, and necessarily prevent its correct and profitable management; and those idle habits, connected with public injury and individual ruin are effectually precluded. A large farm therefore, generally speaking, is far preferable to a small one, in this as in every other point of view. Some persons not having employment for themselves in the superintendance of the different departments of husbandry on their land, have recourse to personal exertion, and substitute themselves for labourers, a plan which is extremely unwise. The true art of farming consists, not in driving the plough or engaging in other menial offices, but in allotting and superintending labour, in recording its results, and contriving how and where to dis-

pose of it to the most perfect advantage. To read, and think, and attend the public markets, and regulate accounts, and observe what others in the same occupation in the neighbourhood, or even at some distance, are engaged in, is of far more importance to the advance of agriculture and the profit of the individual cultivator, than for him to engage in those manual operations, which, in consequence of more practice, are generally performed with more rapidity and success, by common labourers. On urgency of business, or as an example to his men, and to give their employment that estimation and dignity, the idea of which will ever render them at once more happy and more dextrous in it, it will be extremely proper for him to engage occasionally even in these, and his education ought always to have been such, as to enable him to practise them with some degree of skill and neatness, by which he will of course be better enabled to judge when they are well performed by others. But let him consider himself as the manager of a grand manufacturing establishment, requiring peculiar and incessant vigilance; of a concern, in which occurring contingences often require a change of plan, in which the exercise of judgment is perpetually demanded, and through the want of a sagacious and presiding mind the manual labour of many, convertible to extreme advantage, may easily become productive only of mischief, or may have substituted for it negligence, indolence, and dishonesty. This situation of continued superintendence is the proper situation of the farmer; and in proportion as he does not occupy land sufficient to require it, he engages in the profession with incorrect views, and misemploys his time.

But whatever this quantity of land may be thought to be, differing certainly in relation to different individuals, the importance of adequately stocking and preparing what is actually occupied is extreme. To unite the portion of land necessary to occupy the time of the experienced farmer, with the complete means of its fertility and improvement, affords the most auspicious foundation for the hope of success. For frequent and fine tillage, and abundant manure, which are essential to the perfection of husbandry, considerable expense is demanded. The most skilful servants, the most correct implements, the most robust cattle are necessary to produce that improved tilth, which is the most productive cultivation, and will amply repay the extraordinary expense incurred in obtaining them. The procuring of manure in abundance to repair the exhaustion of the soil, and not only keep it in heart, but carry it towards that point of fertility, beyond which, additional expense will be incapable of returning proportional produce, is also a matter often of extreme difficulty and cost. The importance indeed of adequate means is so obvious, that it might perhaps by some be scarcely thought excusable to insist upon the subject. But the frequent and ruinous neglect of this consideration will by others be regarded as an ample justification of enforcing most emphatically and repeatedly the idea, that the perfection of agriculture can never be attained without an unembarrassed and abundant capital. With an inadequate capital on a large extent of land, the same consequences will take place, which formed the most striking and decided objection to those little farms, which, however strange it may now appear, were formerly thought the grand foundation for national plenty and perfect husbandry. The produce must be carried to market, not at the season most advantageous, but almost immediately after the harvest, in order to enable the farmer to extricate himself from immediate embarrassment and prepare the soil, inadequately as it must be done in these circumstances, for fresh cultivation. Commercial monopoly is considerably favoured by this compulsion upon the farmer for selling at whatever price is offered, and artificial scarcity though now not much to be dreaded in this country, is more likely to originate from this circumstance than any other. Those grand operations of spreading marl over large districts, at the rate of a hundred and fifty tons per acre, of conveying immense quantities of dung from towns at the distance of twenty miles, of floating meadows at the cost of five pounds per acre, of draining lands at the expense of three, of paying persons to reside in distant shires or even countries, to acquire superior practical information, or of improving the breeds of sheep and cattle, by giving for the use of a single animal for a season, a price at which our ancestors would have been absolutely astonished and confounded; practices, which, happily, have been far from uncommon in the British empire, and are daily adding, perhaps more than any other cause, to its stability and prosperity, have depended entirely upon abundant capital. Such processes for improvement might as easily be expected in the management of those small farms, formerly so highly extolled, and now so justly in theory exploded, as in the conduct

of large tracts occupied only by men of embarrassed means. The supply of present exigencies preclude those comprehensive and remote views on which the success of the art most materially depends, and unthrifty savings and corroding cares are substituted for the liberal expenses and delighted hopes, which must attend the skilful application of comparative opulence.

Finally, as the art of husbandry is particularly intricate and comprehensive, and those engaged in it are generally persons of slight education, secluded in a great degree from mutual intercourse and comparative observation; ignorance may very justly be considered as an obstacle to its improvement, perhaps the most operative of all. Instead of being collected like artists in cities, and possessing opportunities for animating curiosity, and benefiting by communication, they are scattered over the surface of the country, and have cultivated generally the same lands, and the same prejudices as their ancestors, for a series of generations. Unless there be among the number of those engaged in this art, a certain proportion of persons of intelligent and educated minds, capable of turning the experience of themselves and others to advantage, and deriving assistance to agriculture, from the discoveries of other sciences or arts, it would be vain in any country to expect its rapid approach towards that perfect standard to which every human effort should be referred. That the proportion of such characters has considerably increased of late years in this country, is an observation no less true than pleasing; and in the class of persons engaged in agricultural pursuits, it may be safely affirmed there exists much less tenacity of prejudice, a far greater disposition to research, and openness to conviction, than were to be found in any former age. Even though, in some instances, old and absurd routines of practice may have been maintained with more constancy through the hasty projects and absurd expenses of some innovators, whose failure has checked the spirit of improvement, and unjustly involved in one common ridicule all deviations from ancient custom; these effects, however much to be regretted, are only partial, and information is still making its way into the most remote recesses, and the most stubborn minds. With a view to lessen the darkness and intricacy yet connected with the subject, to prevent random speculations and ruinous projects, with their ill consequences of every kind, it may be observed that it is of the very first importance that persons engaged, particularly on a large scale, in the profession of agriculture, should keep correct accounts of all their transactions, and of all their profits and losses. The advantages of clear accounts are obvious in every other occupation of life. Persons who are engaged in speculations of merchandise, to any extent, and who are known not to attend to this department, are always supposed to be in dangerous circumstances. Agriculture seems by many to be considered an exception to all other species of business; that it may be engaged in without preliminary study, and is capable of being properly conducted, even to a large extent, without any regular accounts, necessary as these are admitted to be in other situations. With respect to experimental agriculture no correct conclusions are to be drawn, but from correct and minute details. Suppositions drawn from general observation are of no utility, or deceive rather than inform. The difficulty of keeping accounts, which, however, commonly neglected, it is allowed never ought to be so, is certainly not inconsiderable. The mode must often be regulated by the nature of the farm. The possessor of open fields, where scraps of land belonging to others are intermingled with his own, can, with extreme difficulty only, keep an account of every part, which, however, it is justly thought of the first importance to do in general, as the knowledge of what every field has paid in certain circumstances is the only basis for correct decision on its application. Small fields are from this, as well as from other causes, extremely inconvenient. They are not only inconvenient in preparation, and attended with much loss in borders and ditches, but they derange the accuracy of accounts if they are not fully noticed, and occupy a great portion of the time of the farmer if they are. When all the produce of several fields is thrown together, which is far from an uncommon case, some objects very interesting to be ascertained must be left entirely to conjecture; and when a comparison is made by guesses, the conclusion formed must be totally invalidated as authority. The separation of crops is therefore an important object with a view to accounts, and is essential, indeed, to their being kept with accuracy. For the rent, tithes, and parochial rates, three separate accounts should be kept, but the amount of all should be divided on every field, for which an account should be kept according to the real contents of it. A distinc-

tion must be drawn between the gross and net contents of the field; as, otherwise, in the comparison of husbandry, that field might be concluded the most advantageous which had the least border, and merely for that reason, the cultivation practised in the other being, in fact, more profitable. But, detail on this subject is here impracticable, and we must be satisfied with observing that without correctness of data for a comparison, the conclusions formed will constitute only a catalogue of errors. The article of sundry expenses must universally have place in a well regulated account, and should include whatever payments concern the farm in general, (and are not included in any distinct article) and not any object or field in particular. With respect to the article of wear and tear, the arable lands will swallow up by far the greater proportion of these expenses. As they principally attach to the team, the proper mode of setting them down is, after ascertaining them at so much per pound on the team account, to charge thus proportionally per acre. The land appropriated for feeding grass will have very little concern in them, and that for mowing by no means much. To settle the expense of the team work, the green food for the teams in summer, the hay and oats consumed, the shoeing and farriering, their real decline in value, the pay for attendance, are each to be itemed down separately; and to apportion the whole expense to the work executed by them, a day-book must contain an account of this work every day in the year, with a specification of the field or business they were engaged in. At the end of the year a clear result may be obtained, by proportionally dividing the amount of the expense among the work. The article manure should be arranged under the head farm-yard, and is one of the most complex and difficult. This account should be charged with the price of the straw used in the yard, at what it could be sold for, deducting the carriage, and it should be credited with the price per week of keeping the cattle. All the labour employed in turning over the dung and cleaning the yard, is charged to this account. The total expense of the dung when carted to the land, is divided by the number of loads, giving so much per load: it should be charged the following year on the lands on which it is spread, although the benefit of it is not confined to that single year: but keeping open the account for a longer time would expose to great and inextricable confusion. One of the most complex of all accounts is that of grass lands fed. To reduce the difficulty, one account should be opened for mowing ground, to which all expenses of rent, tithe, taxes, &c. should be carried for every field mown; while its credit consists of the value, at the market price, of all the mown produce, as delivered to the cattle of any description. The after grass on these fields must be estimated at a certain sum per acre, and charged to the account of feeding ground. To this account must be carried all the debits of the fields fed, while the credit should consist of all the food of the team at a certain weekly estimate; and of any cattle taken to joist. The account for sheep, dairy, and fatting beasts, is each to be charged its peculiar expenses; wages, hurdles, shepherd, &c. for the first; fuel and straw, &c. for the second; and the purchase money of lean stock for fatting beasts. Amidst all this minuteness and complexity of account, order must be produced. The cattle, cows, and sheep, have turnips, with respect to which the estimate of them must be made, not at what they cost, but at what they would sell for eaten off the field, as they cost more than the latter price, and were intended to repay in the crops for which they prepare. The books should be every year balanced, about the season at which the farm was entered upon; and to avoid arbitrary valuation, the old year's accounts must be continued open considerably after the new ones have commenced, till the fatting beasts and the corn are sold, and those points decided on which the profit or loss of the former year depended. By these means conjectures may be, in a great degree, precluded, but not altogether, as these must extend to the estimate of the live stock bought and sold within the year, and to the implements of husbandry. The stock must be estimated every year; and in settling this estimate, their worth at the very time of its being made, that is, the price they would then sell for, must be set down. With respect to fatting beasts, cows, and sheep, this proceeding must equally take place. Every year, also, implements should be valued, and the balance must be carried, where alone it is applicable, to the general head of wear and tear.

The minuteness and accuracy necessary for this or any other efficient mode of account, may deter many from its adoption, and undoubtedly has this effect on thousands. The want of attention, however, to this subject has, unquestionably, been the cause to which many individuals may justly ascribe their failure in this art, and has operated extremely to check the progress of it in gene-

ral. The hints suggested will be sufficient to evince its general and particular importance, and induce some, perhaps, to follow up with care and correctness, a practice which alone can enable them to give the fair results of interesting experiments, or qualify them to ascertain the particular causes of success or failure in general management. The obscurity and perplexity of conjecture can by such means alone be changed, for the clearness of fact and the beauty of order; and, in short, they can thus only decide with truth, and act with confidence.

AGRIMONIA, *agrimony*, in botany, a genus of Dodecandria Digynia class and order: the calyx is one-leafed, permanent, perianthium fenced with an outer calyx; the corolla has five petals; the stamina are capillary filaments, shorter than the corolla; the anthers are small; the pistillum is a germ inferior; the style simple; the stigmas obtuse; no pericardium; there are two roundish seeds. Of this genus there are five species: the A. parviflora grows in the borders of corn-fields, shady places, and hedges in Great Britain, and most parts of Europe; it is perennial, and flowers in June and July. The root is sweet-scented; an infusion of it is used by the Canadians with success in burning fevers. Dr. Hill says, that an infusion of six ounces of the crown of the root in a quart of boiling water, sweetened with honey, and drank to the quantity of half a pint, thrice a day, is a cure for the jaundice. When the plant comes into flower, it will dye wool of a bright full nankeen colour; if gathered in September, it yields a darker yellow. In Prussia it is used for dressing of leather.

AGROSTEMA, *the garland of the field*, in botany, a genus of the Decandria Pentagynia class and order: the calyx is one-leafed; the corolla has five petals; the stamina are ten awl-shaped filaments; the pistillum an ovate germ, with erect styles and simple stygmas; the pericarpium is one-celled; the seeds are numerous. There are four species, viz. 1. A. githago, corns campion, or cockle: 2. A. coronaria, rose-campion: 3. A. flos jovis: and 4. A cœli rosa, smooth campion. The first species is a common annual weed in corn fields, and flowers in June or July; the seeds are black, with a surface like shagreen, and appear in the microscope like a hedge-hog rolled up. The second species is biennial, a native of Italy, the Valais, and Siberia; but so long an inhabitant of English gardens, that it is become a kind of weed. Of this plant there are three varieties, one with deep red, another with flesh-coloured, and a third with white flowers; but they are not much esteemed, as the double rose-campion, which is a fine flower, has excluded the others from most good gardens. The single rose-campions are sufficiently propagated by the self-sown seeds. The variety with double flowers, having no seeds, is propagated by parting the roots in autumn, and planting them in a border of fresh undunged earth, at the distance of about six inches; they should be watered gently till they have taken root; afterwards wet, as well as dung, is injurious to them. In spring they should be removed into the borders of the flower-garden, where they will be very ornamental whilst they flower in July and August. The third species grows naturally on the Swiss and Piedmontese mountains, and in the Palatinate, and was cultivated in 1739, by Mr. Miller. It flowers in July, and the seeds ripen in September. It will thrive best in a moist soil, and a shady situation. The fourth species is annual. It is a native of Italy, Sicily, and the Levant, but being a plant of little beauty, it is preserved in botanic gardens merely for variety.

AGROSTIS, *bent-grass*, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is composed of a glume, consisting of two valves, and inclosing a single flower; it is of an acuminated figure; the corolla is also of an acuminated figure, and composed of two valves; it is scarce so long as the cup, and one of the valves is larger than the other, and aristated; the corolla serves in place of a pericarpium; it surrounds and every way incloses the seed, which is single, roundish, and pointed at each end.

There are 42 species, distributed into two classes; the aristatæ, or those with awns; and the muticæ, or naked without awns. The A. spica venti, silky bent grass, with entire petals, the outer one having a stiff, straight, and very long awn, and the panicle spreading; is an annual, and common in sandy corn-fields. It flowers in June and July, and is liable to be smutted. Horses and goats eat it, but sheep refuse it. The A. arundicea, furnished with a writhed awn; is a native of many parts of Europe, and is a perennial. The Kalmuc Tartars weave mats of it, and thatch their houses with it. The alba, or white bent-grass, is perennial, and grows in ditches, marshes, and moist meadows: there are four varieties, some of which are found

among potatoes in light sandy soils, and some among wheat, flowering from July to September.

AGUE. See MEDICINE.

AGYNEIA, in botany, a genus of the Triandria Monogynia class and order: the male flowers are below the female, the calyx is six-leaved; no corolla; in the male, instead of filaments, are three or four anthers: in the female flowers, the germ of the size of the calyx; neither style nor stigma. There are two species, viz. A. impubes, with leaves smooth on both sides; and A. pubera, with leaves downy underneath: both species are natives of China.

AID *de-camp*, in military affairs, an officer employed to receive and carry the orders of a general. He ought to be alert in comprehending, and punctual and distinct in delivering them. He is seldom under the degree of a captain, and all aids-de-camp have ten shillings a day allowed for their duty.

AIGUISCE, AIGUISSE, EGUISCE, in heraldry, denotes a cross with its four ends sharpened, but so as to terminate in obtuse angles.

It differs from the cross fitchée, in as much as the latter goes tapering by degrees to a point, and the former only at the ends.

AILANTHUS, in botany, a genus of plants of the Decandria Trigynia class and order: it has male, female, and hermaphrodite flowers. The calyx of the male is one-leafed; the corolla has five petals; the stamina have ten filaments, the anthers are oblong and versatile. The calyx and corolla of the female are the same as those of the male; the pistillum has from three to five germs; the styles are lateral, and the stigmas capitate; the pericardium has as many capsules as there are germs; the seeds are solitary. The calyx and corolla of the hermaphrodite is the same with those of the male and female; the stamina have two or three filaments; the pistillum, pericarpium, and seed as in the female. There is one species, viz. A. glandulosa, or tall ailanthus, which is a tree with a sraight trunk, 40 or 50 feet high, a native of China. It grows fast in our climate, and as it rises to a considerable height it is proper for ornamental plantations. A resinous juice, which soon hardens, flows from the wounded bark. The wood is hard, heavy, glossy like satin, and susceptible of a fine polish.

AILE, or AIEL, in law, a writ which lies where a person's grandfather, or great grandfather, being seised of lands, &c. in fee-simple the day that he died, and a stranger abates or enters the same day, and dispossesses the heir of his inheritance.

AJOVEA, in botany, a genus of the Hexandria Monogynia class and order: the calyx is single-leaved, the corolla has three petals, the stigma is divided into six segments, and the fruit is a roundish, single-celled, monospermous berry. There is one species that grows in the forests of Guiana.

AIR, a thin elastic fluid, surrounding the globe of the earth. It is compounded principally of two gases, viz. oxygen and azote, together with a variety of other substances, suspended or dissolved therein. The mechanical and chemical effects of this extensive fluid mass are discussed under various heads of science. See ATMOSPHERE, CHEMISTRY, and the articles thence referred to.

AIR, in music, generally speaking, is any melody, the passages of which are so constructed as to lie within the province of vocal expression, or which, when sung or played, forms that connected chain of sounds which we call tune. The strict import of the word is confined to vocal music, and signifies a composition written for a single voice, and applied to words.

AIR-*gun*, a machine for exploding balls by means of condensed air.

Authors describe two kinds of this machine, viz. the common one, and what is called the magazine air-gun. See PNEUMATICS.

AIR-*pipes*, a contrivance invented by Mr. Sutton, a brewer of London, for clearing the holds of ships, and other close places, of their foul air. The principle upon which this contrivance is founded is well known. It is no other than the rarefying power of heat, which, by causing a diminution of the density of the air in one place, allows that which is in contact with it to rush in, and to be succeeded by a constant supply from remoter parts, till the air becomes every where equally elastic. If a tube, then, be laid in the well-hold, or any other part of a ship, and the upper part of this tube be sufficiently heated to rarefy the impending column of air, the equilibrium will be maintained by the putrid air from the bottom of the tube, which being thus drawn out, will be succeeded by a supply of fresh air from the other parts of the ship; and by continuing the operation, the air will be changed in all parts of the ship. Upon this principle, Mr. Sutton proposed to purify the bad air of a ship, by means of the fire used for the coppers, or boiling places, with which every ship is provided. Under every such

copper or boiler, there are two holes separated by a grate, one for the fire and the other for the ashes; and there is also a flue, communicating with the fire-place, for the discharge of the smoke. The fire, after it is lighted, is preserved by the constant draught of air through these two holes and the flue; and if the two holes are closed, the fire is extinguished. But when these are closed, if another hole, communicating with any other airy place, and also with the fire, be opened, the fire will of course continue to burn. In order to clear the holds of the ships of the bad air, Mr. Sutton proposed to close the two holes above mentioned, viz. the fire-place and ash-place, with substantial iron doors, and to lay a copper or leaden pipe, of sufficient size, from the hold into the ash-place, and thus to supply a draught of air for feeding the fire; a constant discharge of air from the hold will be thus obtained, and fresh air will be supplied down the hatches, and by such other communications as are open into the hold. If other pipes are connected with this principal pipe, communicating either with the wells or lower decks, the air that serves to feed the fire will be drawn from such places.

Air-*shafts*, among miners, are holes made from the open air to meet the adits, and supply them with fresh air.

These, when the adits are long, or exceeding thirty or forty fathoms, become highly necessary, as well to give vent to the damps and noxious vapours, as to let in fresh air.

Air-*trunk*, a simple contrivance by Dr. Hales, for preventing the stagnation of putrid effluvia, and purifying the air in jails and close rooms; which consists of a square trunk open at both ends, one of which is fixed in the ceiling, and the other is extended to a considerable height above the roof. The noxious effluvia, ascending to the top of the room, escape by this trunk. Some of these have been nine, and others six inches in the clear; but whatever be their diameter, their length should be proportionable, in order to promote the ascent of the vapour. As the pressure of fluids, and consequently of the air, corresponds to their perpendicular altitude, the longer these trunks are, so much the greater will be the difference between columns of air pressing at the bottom and at the top; and of course so much the greater will be their effect. See Ventilator.

Air-*vessel*, in hydraulics, is a name given to those metalline cylinders, which are placed between the two forcing-pumps in the improved fire-engines. The water is injected by the action of the pistons through two pipes, with valves, into this vessel; the air previously contained in it will be compressed by the water, in proportion to the quantity admitted, and by its spring force the water into a pipe, which will discharge a constant and equal stream; whereas in the common squirting engine the stream is discontinued between the several strokes. Other water-engines are furnished with vessels of this kind.

Air-*vessels*, in botany, are certain canals, or ducts, whereby a kind of absorption and respiration is effected in vegetable bodies.

Air-vessels have been distinguished from sap-vessels; the former being supposed to correspond to the trachea and lungs of animals; the latter to their lacteals and blood-vessels.

Dr. Grew, in an inquiry into the motion and cause of the air in vegetables, shews, that it enters them various ways, not only by the trunk, leaves, and other parts above ground, but at the root. For the reception, as well as expulsion of the air, the pores are so very large in the trunks of some plants, as in the better sort of thick walking-canes, that they are visible to a good eye without a glass; but with a glass the cane seems as if it were stuck full of large pin-holes, resembling the pores of the skin in the ends of the fingers and ball of the hand. In the leaves of the pine, through a glass, they make an elegant shew, standing almost exactly in rank and file throughout the length of the leaves. But though the air enters in partly at the trunk, and also at other parts, especially in some plants, yet its chief admission is at the root: much as in animals, some part of the air may continually pass into the body and blood by the pores of the skin; but the chief draught is at the mouth. If the chief entrance of the air were at the trunk, before it could be mixed with the sap in the root it must descend; and so move not only contrary to its own nature, but in a contrary course to the sap: whereas, by its reception at the root, and its transition from thence, it has a more natural and easy motion of ascent. The same fact is farther deduced from the fineness and smallness of the diametral apertures in the trunk, in comparison of those in the root, which nature has plainly designed for the separation of the air from the sap, after they are both together received into them.

Air-vessels are found in the leaves of all

plants, and are even discoverable in many without the help of glasses; for upon breaking the stalk or chief fibres of a leaf, the likeness of a fine woolly substance, or rather of curious small cobwebs, may be seen to hang at both the broken ends. This is taken notice of not only in some few plants, as in scabious, where it is more visible; but may also be seen more or less in most others, if the leaves be very tenderly broken. This wool is really a skein of air-vessels, or rather of the fibres of the air-vessels, loosed from their spiral position, and so drawn out in length.

AIRA, *hair-grass*, in botany, a genus of the Triandria Digynia class and order, and of the natural order of Grasses. There are twenty-five species, some of which have awns and others have none. The A. aquatica, water hair-grass, generally grows in the margin of pools and watery places, running into the water to a considerable distance, and is known by the purple or bluish colour of the panicles, and sweet taste of the flowers. It is a perennial, and flowers in May and June. To this grass has been attributed the sweetness of Cottenham cheese, and the fineness of Cambridge butter. The A. cæspitosa, or turfy-hair grass, grows in moist meadows and woods, is perennial, it flowers in June and July, sometimes trailing on the ground to the length of several feet, and the panicle exhibiting a beautiful silky appearance: cows, goats, and swine eat it, but horses are not fond of it. It is the roughest and coarsest grass that grows in pastures or meadows, and is called by the common people hassocks, rough-caps, and bull's faces. To get rid of it, the land should be first drained, and the tufts of the noxious weeds pared off and burnt. The ashes yield a good manure. The A. flexuosa, or waved mountain grass, is the principal grass on Banstead Downs, and the Mendip Hills. It is difficult of cultivation.

AITONIA, in botany, so called from Mr. Aiton, his Majesty's late gardener at Kew, a genus of the Monadelphia Octandria class and order, and of the natural order of Columniferæ. There is but one species, viz. A. capensis, found at the Cape of Thunberg. It has a shrubby stalk six feet high, and a fruit resembling that of the winter cherry. With us it is of slow growth, and seldom exceeds three feet in height. At a sufficient age it produces flowers and fruit through the greatest part of the year.

AJUGA, *bugle*, in botany, a genus of the Didynamia Gymnospermia class of plants: he flower is monopetalous and ringent; the upper lip being small and bifid; the lower one large and trifid: there is no pericarpium: the seeds are contained in the cup of the flower, and are four in number. There are 10 species.

AIZOON, in botany, a genus of the Polyandria Pentagynia: the calyx is a one-leafed perianthium; no corolla; the stamina have many capillary filaments; the anthers are simple, the pistillum has a five-cornered germ, the seeds are several: there are ten species, all belonging to the hot climates.

ALA, in botany, is used in different senses; sometimes it denotes the hollow between the stalk of a plant and the leaves; sometimes it is applied to the two side petals of the papilionaceous flowers, the upper petal being called the vexillum, and the lower one the carina; others use it for the slender membranaceous parts of some seeds, thence said to be alated; and others, again, for the membranaceous expansions found on the stems of plants, thence denominated alated stalks.

ALABASTER, a well known description of stone used by statuaries and others. It is the sulphate of lime. See CHEMISTRY and MINERALOGY.

ALÆ, in anatomy, is sometimes used for the lobes of the liver, the nymphæ of the female pudendum, the two cartilages which form the nostril, the arm-pits, young stems or branches, &c.

ALANGIUM, in botany, a genus of the Decandria Monogyria class and order; the characters of which are, that it has from 6 to 10 linear petals, from 10 to 12 stamina; the calyx dentated; the fruit a spherical berry, single-celled, containing from one to three seeds: there is only one species, viz. A. pungens.

ALATED in botany, an epithet applied to the seed, stem, or leaf-stalk; a seed is alated, when it has an ala or membrane affixed to it, which, by its flying, serves to disperse it. The foot stalk of a leaf is alated, when it spreads out the sides. Alated leaves are those made up of several pinnated ones.

ALAUDA, *lark*, in ornithology, a genus of birds of the order of Passeres; the characters of which are, that the beak is cylindrical, subulate, and straight, bending towards the point, the mandibles are of equal size and opening downwards at their base; the tongue is bifid; and the hinder claw is straighter and longer than the toe. Pennant adds, that the nostrils are covered with feathers or bristles, and the toes divided to their origin. There are 33 species, but we shall notice only two of them. 1. A. arven-

sis, or sky-lark, the specific characters of which are, that the two outermost quills of its tail are white lengthwise externally, and the intermediate ones are ferruginous on the inside: the length is about seven inches. The males of this species are somewhat browner than the females; they have a black collar, and more white on the tail; their size is larger, and their aspect bolder; and they exclusively possess the faculty of singing. When the female is impregnated, she forms her nest between two clods of earth, and lines it with herbs and dry roots, being no less attentive to the concealment than to the structure of it. It sometimes builds its nest among corn and in high grass. Each female lays four or five eggs, which are greyish, with brown spots; and the period of her incubation is about 15 days. The young may be taken out of the nest when they are a fortnight old, and they are so hardy, that they may be easily brought up. The parent is very tender of her young; and though she does not always cover them with her wings, she directs their motions, supplies their wants, and guards them from danger. The common food of the young sky-larks is worms, caterpillars, ants-eggs, and even grasshoppers; and in maturity, they live chiefly on seeds, herbage, and all vegetable substances. Those birds, it is said, that are destined for singing, should be caught in October or November; the males should, as much as possible, be selected: and when they are untractable they should be pinioned, lest they injure themselves by their violence against the roof of the cage. As they cannot cling by the toes, it is needless to place bars across their cage; but they should have clean sand at the bottom of it, that they may welter in it and be relieved from the vermin which torment them. In Flanders, the young ones are fed with moistened poppy-seeds and soaked crumbs of bread; and when they begin to sing, with sheep's and calves' hearts, hashed with hard eggs; to which are added, wheat, spilt-oats, millet, linseed, and the seeds of poppy and hemp, steeped in milk. Their capacity of learning to sing is well known; and so apt are some cock larks, that, after hearing a tune whistled with the pipe, they have caught the whole, and repeat it more agreeably than any linnet or canary bird. In summer the larks seek the highest and driest situations; but in winter they descend to the plains, and assemble in numerous flocks. In the former season they are very lean, and in the latter very fat, as they are always on the ground, and constantly feeding. In mounting the air, they ascend almost perpendicularly, by successive springs, and hover at a great height; but in descending, they make an oblique sweep, unless they are pursued by a ravenous bird, or attracted by a mate, in either of which cases they fall like a stone These small birds, at the height to which they soar, are liable to be wafted by the wind; and they have been observed at sea, clinging to the masts and cordage of ships. Sir Hans Sloane observed some of them 40 miles from the coast, and Count Marsigli met with them on the Mediterranean. It is conjectured, that those which are found in America have been driven thither by the wind. Some have supposed, that they are birds of passage, at least in the more southern and milder climates of Europe; but they are occasionally concealed under some rock or sheltered cave. The lark is found in all the inhabited parts of both continents, as far as the Cape of Good Hope; this bird, and the wood-lark, are the only birds which sing whilst they fly. The higher it soars, the more it strains its voice, and lowers it till it quite dies away in descending. When it ascends beyond our sight, its music is distinctly heard; and its song, which is full of swells and falls, and thus delightful for its variety, commences before the earliest dawn. In a state of freedom, the lark begins its song early in the spring, which is its season of love and pairing, and continues to warble during the whole of the summer. The Honorable Daines Barrington reckons this among the best of the singing larks: and as it copies the warble of every other bird, he terms it a mocking-bird. These birds, which are esteemed a delicacy for the table, though Linnæus thinks the food improper for gravelly complaints, are taken with us in the greatest numbers, in the neighbourhood of Dunstable. The season begins about the 14th of September, and ends the 25th of February; and during this time, about 4000 dozen are caught for supplying the London markets. Those caught in the day, are taken in clap-nets, till the 14th of November. But when the weather becomes gloomy, and also in the night, the larker makes use of a trammel-net, 27 or 28 feet long, and five broad, which is put on two poles 18 feet long, and carried by men under each arm, who pass over the fields, and quarter the grounds as a setting dog. When they see or feel a lark strike the net, they drop it down, and thus the birds are taken. The darkest nights are the most proper for their sport; and the net will not only take larks, but all other birds that roost

on the ground; among which are woodcocks, snipes, partridges, quails, field-fares, and several others. In the depth of winter, people sometimes take great numbers of larks by nooses of horse-hair. The method is this: take 100 or 200 yards of packthread; fasten at every six inches a noose made of double-horse hair; at every 20 yards the line is to be pegged down to the ground, and so left ready to take them. The time to use this is when the ground is covered with snow, and the larks are to be allured to it by some white oats, scattered among the nooses. They will soon fly to them, and, in eating, will be hung by the nooses. They must be taken away as soon as three or four are hung, otherwise the rest will be frightened; but though the others are scared away just where the sportsman comes, some will be feeding at the other end of the line, and the sport may be thus continued for a long time. As the sky-lark is a kind of mocking-bird, and apt to catch the note of any other which hangs near it, even after its own note is fixed, the bird-fanciers often place it next to one which has not been long caught, in order to keep the caged sky-lark honest. Plate II. Aves, fig. 1.

2. A. arborea, wood-lark of English writers, is specifically characterised by a white annular belt, encircling its head. This bird is smaller than the sky-lark, and of a shorter thicker form; the colours of the plumage are paler; the first feather of the wing is shorter than the second; the hind claw is very long and somewhat bent; it perches on trees; it haunts the uncultivated tracts near copses, without penetrating the woods, whence its name; its song resembles more the warble of the nightingale, or the whistling of the black-bird, than that of the sky-lark; its note being less sonorous and less varied, though not less sweet; and it is heard not only in the day, but in the night, both when it flies and when it sits on a bough. This bird builds on the ground, and forms its nest on the outside with moss, and on the inside with dried bents, lined with a few hairs, and conceals it with a turf; and the situation it selects is ground where the grass is rank, or become brown. It lays four or five eggs, which are dusky and blotched with deep brown; its fecundity is inferior to that of the sky-lark, and its numbers are not so great: it breeds earlier, since its young are sometimes flown in the middle of March, and therefore they pair in February, at which time, and not before, they part with their last year's brood; whereas the common lark does not hatch before the month of May. This is a very tender and delicate bird; so that it is impossible to rear the young taken out of the nest: but this is the case only in England and such cold climates, for in Italy they are removed from the nest, and reared at first like the nightingale, and afterwards fed upon panic and millet. The wood-lark feeds on beetles, caterpillars, and seeds: its tongue is forked; its stomach muscular and fleshy; and it has no craw, but a moderate dilatation of the lower part of the œsophagus, and its cœca are very small. It lives ten or twelve years. The males are distinguished from the females by their larger size; the crown of the head is also of a darker colour, and the hind nail longer; its breast is more spotted, and its great wing-quills edged with olive, which in the female is grey. The wood-lark mounts high, warbling its notes, and hovering in the air; it flies in flocks during the winter colds; it is found in Sweden and Italy, and is probably dispersed through the intervening countries, and consequently over the greatest part of Europe. It is also found in Siberia, as far as Kamtschatka, and likewise in the island of Madeira. The best time for taking this bird for the cage is July, or the preceding or following month. Those that are put into the cage at this time, sing presently, but their song-time is not lasting, for they soon fall to moulting, in which state many die; but if they get over it, they commonly prove very healthful afterwards, become very tame and familiar, and sing sweetly. Those which are taken in the latter end of September are generally very strong and sprightly; but they do not sing till after Christmas. Those taken in January and February finally prove the best of all; they generally begin singing in two or three days, or at the utmost in a week after they are taken. The cock-bird of this kind is known from the hen by the loudness and length of his call, by his tallness as he walks about the cage, and by his doubling his notes in the evening, as if he were going with his mate to roost. A better rule than all others, however, is his singing strong; for the hen wood-lark sings but very weakly. Both the cock and hen of this kind are tender, and subject to many disorders; the principal of these are cramps, giddiness of the head, and breeding lice. Cleanliness is the best cure for the first and the last of these complaints; but we know of no cure for the other. A good strong bird will last very well for five or six years, and frequently improve during the whole of this time. The lark is not only a very agreeable bird for

the cage, but it will also live upon almost any food, so that it have once a week a fresh tuft of three-leaved grass put into the cage with it. The wood-lark is one of the sweetest of our singing-birds, and is indeed very little inferior to the nightingale, when in good health; but we are not to judge by such as are made feeble by improper food, or want of cleanliness in their cages.

ALBINOS, in zoology, a denomination given to the white negroes of Africa, who have light hair, blue eyes, and a white body, resembling that of the Europeans, when viewed at a distance; but, upon a nearer approach, the whiteness is pale and livid, like that of leprous persons, or of a dead body. Their eyes are so weak that they can hardly see any object in the day, or bear the rays of the sun, and yet, when the moon shines, they see as well, and run through the deepest shades of their forests, with as much ease and activity, as other men do in the brighest day-light. Their complexion is delicate; they are less robust and vigorous than other men; they generally sleep in the day, and go abroad in the night. The negroes regard them as monsters, and will not allow them to propagate their kind. In Africa this variety of the human species very frequently occurs. Wafer informs us, that there are white Indians of the same general character among the yellow or copper-coloured Indians of the isthmus of Darien. It has been a subject of inquiry, whether these men form a peculiar and distinct race, and a permanent variety of the human species, or are merely individuals who have accidentally degenerated from their original stock. Buffon inclines to the latter opinion, and he alleges in proof of it, that in the isthmus of America a husband and wife, both of a copper colour, produced one of these white children; so that the singular colour and constitution of these white Indians must be a species of disease which they derive from their parents; and the production of whites by negro parents, which sometimes happens, confirms the same theory. According to this author, white appears to be the primitive colour of nature, which may be varied, by climate, food, and manners, to yellow, brown, and black; and which, in certain circumstances, returns, but so much altered, that it has no resemblance to the original whiteness, because it has been adulterated by the causes that are assigned. Nature, he says, in her most perfect exertions, made men white; and the same nature, after suffering every possible change, still renders them white: but the natural or specific whiteness is very different from the individual or accidental. Of this we have examples in vegetables, as well as in men and other animals. A white rose is very different, even in the quality of whiteness, from a red rose, which has been rendered white by the autumnal frosts. He deduces a farther proof that these white men are merely degenerated individuals, from the comparative weakness of their constitution, and from the extreme feebleness of their eyes. This last fact, he says, will appear to be less singular, when it is considered that in Europe very fair men have generally weak eyes; and he has remarked that their organs of hearing are often dull: and it has been alleged by others, that dogs of a perfectly white colour are deaf. This is a subject which demands farther investigation. Buffon's Natural History.

ALBUCA, in botany, a genus of the Hexandria Monogynia class and order: corolla six-petalled; the inner ones connivent; outer ones spreading; style triangular: this genus is distinguished into those species, three of whose stamina are fertile; and into others in which all the stamina are fertile: of the former there are six species; of the latter eight. They are all found at the Cape.

ALBUMEN, in chemistry, a term to denote the white of egg, and all glary, tasteless substances, which, like it, have the property of coagulating into a white, opaque, tough, solid substance, when heated a little under the boiling point. This substance forms a constituent of many of the fluids of animal bodies, and when coagulated, it constitutes also an important part of their solids. Substances analogous to it have been noticed in the vegetable kingdom. The essential characters of albumen are the following: 1. In its natural state it is soluble in water, and forms a glary, limpid liquid, having very little taste: in this state it may be employed as a paste and a varnish. 2. The solusion is coagulated by acids, in the same way as milk is acted upon; and also by heat of the temperature of 170°, and by alcohol. 3. Dissolved in water, it is precipitated by the infusion of tan; and also in the form of white powder by the salts of most of the white metals, as silver, mercury, lead, and tin. 4. When burnt it emits ammonia, and when treated with nitric acid, yields azotic gas. The juice of the papaw tree yields albumen; so also does the juice of the fruit of the hibiscus esculentus: that obtained from the latter has been used in the West Indies as a

substitue for whites of eggs in clarifying sugar.

ALBURNUM, denotes the white, soft substance that lies between the inner bark and the wood of trees, composed of layers of the former, which have not attained the solidity of the latter. Plants, after they have germinated, do not remain stationary, but are continually increasing in size. A tree, for instance, every season adds considerably to its bulk. The roots send forth new shoots, and the old ones become longer and thicker. The same increment takes place in the branches and the trunk. A new layer of wood, or rather of alburnum, is added annually to the tree in every part, just under the bark; and the former layer of alburnum assumes the appearance of perfect wood. The alburnum is found in largest quantities in trees that are vigorous; though in such as languish and are sickly there is a great number of beds. In an oak six inches in diameter the alburnum is said to be nearly equal in bulk to the wood.

ALCA, *auk*, in ornithology a genus of the order of Anseres, in the Linnæan system, the characters of which are, that the bill is without teeth, short, compressed, convex, frequently furrowed transversely; the inferior mandible is gibbous before the base; the nostrils are behind the bill; and the feet have generally three toes. This genus comprehends 12 species, of which we shall notice the following: A. torda, with four furrows on the bill, and a white line on each side running from the bill to the eyes. This is the alca of Clusius and Brisson; the pinguin of Buffon; and the razor-bill, auk, or murre of Pennant, Ray, Willughby, Albinus, Edwards, and Latham. This species weighs about 22½ ounces; its length is about 18 inches, and breadth 27. These birds, in company with the guillemot, appear in our seas in the beginning of February; but do not settle in their breeding-places till they begin to lay, about the beginning of May. When they take possession of the ledges of the highest rocks that hang over the sea, they sit close together, and in rows one above another, and form a very grotesque appearance. They lay only one egg at a time, which is of a large size, in proportion to that of the bird; being three inches long, either white or of a pale sea-green, irregularly spotted with black: if this egg be destroyed, both the auk and the guillemot will lay another, and if this be taken, a third; as they make no nest, they deposit the egg on the bare rock, poising it in such a manner as no human art can effect, and fixing it by means of the viscous moisture that bedews its surface on its exclusion; and though such multitudes of eggs are contiguous to each other, each bird distinguishes its own. These eggs serve as food to the inhabitants of the coasts which the birds frequent; and are procured with great hazard by persons let down with ropes, held by their companions, and who for want of stable footing are sometimes precipitated down the rocks, and perish together. They are found in the northern parts of America, Europe, and Asia. They come to breed on the Ferroe islands, along the west of England, and on the Isle of Wight, where they add to the multitude of sea-fowl that inhabit the great rocks called the Needles. Their winter residence is not positively ascertained. As they cannot remain on the sea in that season, and never appear on shore, nor retire to southern climates, Edwards supposes that they pass the winter in the caverns of rocks, which open under water, but rise internally as much above the level of the flood as to admit a recess, and here, as he apprehends, they remain torpid, and live upon their abundant fat. The pace of this bird is heavy and sluggish; and its ordinary posture is that of swimming or floating on the water, or lying stretched on the rocks or on the ice.

A. impennis, A. major of Brisson, penguin of Ray, Martin, Edwards, &c. and great auk of Pennant and Latham, has its bill compressed and furrowed on both sides, and has an oval spot on each side before the eyes. Its length to the end of its toes is three feet; the bill to the corner of the mouth is 4¼ inches: the wings are so small as to be useless for flight; their length, from the tip of the longest quill-feathers to the first joint, being only 4¼ inches: and these birds are therefore observed by seamen never to wander beyond soundings, and by the sight of them they are able to ascertain the nearness of the land. They can scarcely even walk, and of course continue on the water, except in the time of breeding. According to Mr. Martin, they breed on the isle of St. Kilda, appearing there in the beginning of May, and retiring in the middle of June. They lay one egg, six inches long, of a white colour; and if the egg be taken away, no other is laid in the same season. Mr. Macaulay, in his history of St. Kilda, observes, that this bird does not visit that island annually, but sometimes keeps away for several years together; and that it lays its eggs close to the sea-mark, and is inca-

pable, by the shortness of its wings, of mounting higher. Birds of this species are said not to be numerous; they seldom appear on the coasts of Norway. They are met with near Newfoundland and Iceland. They do not resort annually to the Ferroe islands, and they rarely descend more to the south in the European seas. They feed on the cyclopterus and such fish, and on the rose-root and other plants. The skins are used by the Esquimaux for garments. These birds live in flocks at sea, and never approach the land except in very severe cold; and in this case they are so numerous, that they cover the water like a thick dark fog. The Greenlanders drive them on the coast, and catch them with the hand, as they can neither run nor fly. At the mouth of the Ball river they afford subsistence to the inhabitants in the months of February and March, and their down serves to line winter garments. Plate II. Aves, fig. 2.

A. psittacula, or perroquet auk of Pennant and Latham, is found in the sea that lies between the northern parts of Asia and America, sometimes by day in flocks swimming on the water, though not very far from land, unless driven out by storms, and in the night harbouring in the crevices of rocks. About the middle of June they lay upon the rocks or sand a single egg, about the size of that of a hen, and of a dirty white or yellowish colour, spotted with brown, which is esteemed good. These birds, like others of the same class, are stupid, and are mostly taken by the natives, who place themselves in the evening among the rocks, dressed in garments of fur with large open sleeves, into which the birds fly for shelter as the night comes on, and thus they become an easy prey. They sometimes at sea mistake a ship for a roosting place, and thus warn navigators of their being near the land at the access of night, or on the approach of storms.

A. cirrhata, tufted auk of Pennant and Latham, is entirely black, nearly 18 inches long; swimming about for whole days in the sea, where it dives well, and occasionally flies swiftly, but never departing far from the rocks and islands; and feeding on shrimps, crabs, and other shell-fish, which it forces from the rocks with its strong bill; in the night it comes to shore, burrows about a yard deep under ground, and makes a nest with feathers and sea-weed, in which it lodges with its mate, being monogamous. It lays one egg in May or June, which is fit to be eaten and used for food, but the flesh of the bird is hard and insipid. This species inhabits the shores of Kamtschatka, the Kurile islands, and those that lie between Kamtschatka and America.

A. arctica, or puffin, found on the coasts of England; and particularly in Priestholm isle, where they are seen in flocks almost innumerable. They come in the beginning of April, and depart in August. Fig. 3.

ALCEA, *hollyhock*, in botany, a genus of the Monadelphia Polyandria class of plants, the calyx of which is a double perianthium; the exterior one, which is permanent, consists of a single patent leaf, divided into six segments; the interior is also permanent, and consists of a single leaf divided into five segments: the corolla consists of five very large patent and emarginated petals, growing together at the base: the fruit is composed of numerous capsules, each containing a single compressed kidney-shaped seed. There are five species. The hollyhock grows wild in the country of Nice. The colour of the flowers is accidental, and the double flowers are only varieties proceeding from culture. These varieties are not constant; but the greatest number of plants, produced from seeds carefully saved from the most double flowers, will arise nearly the same with the plants from which they are taken, provided they are kept separate from single or bad coloured flowers. The A. rosea grows naturally in China: a dwarf sort, with beautiful double variegated flowers, has been some years in great esteem under the name of the Chinese hollyhock. Hollyhocks are propagated from seeds, sown half an inch deep in a bed of light earth, about the middle of April. When the plants have put out six or eight leaves, they are to be transplanted into nursery beds, and in October they are to be removed to the situation where they are to remain.

ALCEDO, *kingsfisher*, in ornithology, a genus of the order of Picæ. The characters are, that the bill is three-sided, thick, straight, long, and pointed; the tongue is fleshy, very short, flat, and sharp, and the feet are for the most part gressory. There are 41 species. These birds are dispersed over the whole globe; inhabiting chiefly the water, and living upon fish, which they catch with surprising alertness, and swallow whole, rejecting afterwards the undigested parts; though their wings are short, they fly swiftly; their prevailing colour is sky blue; their nostrils are small, and generally covered. A. ispida, ispida of Gesner, Ray, European kingsfisher of Pennant, and common kings-

fisher of Latham, is the only one we shall notice: it is short-tailed, sky-blue above, fulvous below, and its straps are rufous. This bird is 7 inches long and 11 broad, of a clumsy shape, the head and bill being very large, and the legs disproportionately small. The kingsfisher frequents the banks of rivers, and feeds on fish. It takes its prey somewhat in the manner of the osprey, balancing itself at a certain distance over the water for some time, and then darting below the surface brings the prey up in its feet. When it remains suspended in the air, in a bright day, the plumage exhibits a most beautiful variety of the most dazzling and brilliant colours. It makes its nest in holes in the sides of the cliffs, which it scoops to the depth of three feet, and lays from five to nine eggs, of a very beautiful semi-transparent white. The nest is very fetid, on account of the refuse of fish with which the young are fed. It begins to hatch its young early in the season, and excludes the first brood in the beginning of April. Whilst the female is thus employed, the male is unremitting in his attention, supplying his mate with fish in such abundance, that she is found at this season plump and fat. He ceases to twitter at this time, and enters the nest as quietly and privately as possible. The young are hatched in about 20 days; but differ both in size and beauty. Some have even doubted, whether the kingsfisher of the moderns and the alcyon of the ancients are the same bird. But the description of Aristotle sufficiently identifies them. The alcyon, says that philosopher, is not much larger than a sparrow; its plumage is painted with blue and green, and lightly tinged with purple; these colours are not distinct, but melted together, and shining variously over the whole body, the wings, and the neck: its bill is yellowish, long, and slender. The habits of these birds also resemble one another. The alcyon was solitary and pensive; and the kingsfisher is almost always seen alone, and the pairing season is of short duration. The former was not only an inhabitant of the sea shore, but haunted the banks of rivers; and the latter has also been found to seek shell-fish and large worms, that abound on the shore of the sea, and in rivulets that flow into it. The alcyon was seldom seen, and rapid in its flight; it wheeled swiftly round ships, and instantly retired into its little grot on the shore. The same character belongs also to the kingsfisher. The alcyon and the kingsfisher have the same mode of taking their prey, by diving vertically upon it. The kingsfisher is the most beautiful bird in our climates, as to the richness and luxuriance of the colours of its plumage. It has, says Buffon, all the shades of the rainbow, the brilliancy of enamel, and the glossy softness of silk; and Gesner compares the glowing yellow red, which colours the breast, to the red glare of a burning coal; and yet the kingsfisher has strayed from those climates where its resplendent and glowing colours would appear to the greatest advantage. There is a species that is common in all the islands of the South Sea; and Forster, in his observations in Captain Cook's second voyage, has remarked, that its plumage is much more brilliant between the tropics than in the regions situated beyond the temperate zone, in New Zealand. In the language of the Society Islands, the kingsfisher is called Erooro, and at Otaheite it is accounted sacred, and not allowed to be taken or killed. Kingsfishers were found, not only at Otaheite, but in Huaheine and Ulietea, and in the islands that are scattered over the South Sea, though they are more than 1500 leagues distant from any continent. These kingsfishers are of a dull green, with a collar of the same about their neck. The islanders entertain a superstitious veneration for them. The chief at Ulietea intreated Capt. Cook's companions, in a very serious tone, to spare the kingsfishers and herons of his island, giving permission to kill all the other birds. There are 20 species in Africa and Asia, and eight more that are known in the warm parts of America. The European kingsfisher is scattered through Asia and Africa: many of those sent from China and Egypt are found to be the same with ours, and Belon has met with them in Greece and in Thrace. This bird, though it derives its origin from the hottest climates, bears the rigour of our seasons. It is seen in the winter along the brooks, diving under the ice, and emerging with its prey. The Germans have called it eissvogel, or ice-bird; and it has been found even among the Tartars and Siberians. The Tartars and Ostiacs use the feathers of these birds for many superstitious purposes. The former use them as love-amulets; pretending that those which float on water will induce a woman who is touched with them to fall in love with the person who thus applies it. The Ostiacs take the skin, the bill, and the claws of this bird, and enclose them in a purse; and whilst they preserve this amulet, they think they have no ill to fear. Credulity has ad-

mitted and reported many other similar tales concerning the extraordinary powers and virtues of this bird; but it is needless to recite them. Its flesh has the odour of musk, and is unpalatable. Plate II. Aves, fig. 4.

ALCHEMY, that branch of chemistry which had for its principal objects the transmutation of all the metals into gold; the panacea, or universal remedy for all diseases; and the alkahest, or universal menstruum. Those who pursued these delusive projects gradually assumed the form of a sect, under the name of Alchemists, a term made up of the word chemist, and the Arabian article *al* as a prefix. The alchemists laid it down as a first principle, that all metals are composed of the same ingredients, or that the substances at least which compose gold exist in all metals, and are capable of being obtained from them. The great object of their researches was to convert the baser metals into gold. The substance which produced this property they called *lapis philosophorum*, "the philosophers' stone;" and many of them boasted that they were in possession of that grand instrument. The alchemists were established in the west of Europe as early as the ninth century; but between the eleventh and fifteenth alchemy was in its most flourishing state. The principal alchemists were Albertus Magnus, Roger Bacon, Arnoldus de Villa Nova, Raymond Lully, and the two Isaacs of Holland.

ALCHIMILLA, or ALCHEMILLA, *ladies' mantle*, in botany, a genus of the Tetrandria Monogynia class of plants, the calyx of which is a single-leafed perianthium: there is no corolla, nor any pericarpium; the cup finally becomes a capsule, containing a single elliptical and compressed seed. There are four species. A. vulgaris, common ladies' mantle, or beanfoot, is frequent in meadows and pastures in England. It is perennial, and flowers in June and July. Horses, sheep, and goats eat it. The great richness of the milk in the celebrated dairies of the Alps is attributed to the plenty of this plant, and that of the rib-wort plantain. The plant is astringent, and in Gothland and other places a tincture of its leaves is given in spasmodic and convulsive cases. A. alpina, cinquefoil, or alpine ladies' mantle, grows naturally in the North of England, North Wales, and in the Highlands of Scotland. It is a native of the northern parts of Europe, and is admitted into the gardens on account of its elegance. The A. pentaphyllea grows naturally on the Alps, and is found in the botanical gardens in this country: it may be propagated by parting the roots in autumn. They should have a moist soil, and a shady situation.

ALCHORNEA, in botany, a genus of the Monadelphia Octandria class and order, of which there is but a single species. Male, calyx three, five-leaved; corolla none: female, calyx five-toothed; corolla none; styles two-parted.

ALCOHOL, a term applied by chemists to the purely spirituous part of liquors that have undergone the vinous fermentation. It is in all cases the product of the saccharine principle, and is formed by the successive processes of vinous fermentation and distillation. Various kinds of ardent spirits are known in commerce, as brandy, rum, &c.; but they differ in colour, taste, smell, &c. The spirituous part, however, is the same in each, and may be procured in its purest state by a second distillation, which is termed rectification. See DISTILLATION, FERMENTATION, and RECTIFICATION. Alcohol is procured most largely in this country from a fermented grain-liquor; but in France and other wine countries, the spirit is obtained from the distillation of wine, hence the term spirit of wine. See BRANDY. Alcohol is a colourless, transparent liquor, appearing to the eye like pure water. It possesses a peculiar penetrating smell, distinct from the proper odour of the distilled spirit from which it is procured. To the taste it is excessively hot and burning; but without any peculiar flavour. From its lightness, the bubbles which are formed by shaking subside almost instantaneously, which is one method of judging of its purity. Alcohol may be volatilized by the heat of the hand. It is converted into vapour at the temperature of 55° of Fahrenheit, and it boils at 165°. It has never been frozen by any degree of cold, natural or artificial, and on this account it has been much used in the construction of thermometers. Alcohol mixes with water in all proportions, and during the mixture heat is extricated, which is sensible to the hand. At the same time there is a mutual penetration of the parts, so that the bulk of the two liquors when mixed is less than when separate: consequently the specific gravity of the mixture is greater than the mean specific gravity of the two liquors taken apart. Alcohol is supposed to consist of

Carbon	28.53
Hydrogen	7.87
Water	63.6
	100.00

Its uses are many and important: it is employed as a solvent for those resinous gums which form the basis of numerous varnishes: it is employed also as the basis of artificial cordials and liquors, to which a flavour and additional taste are given by particular admixtures: it serves as a solvent for the more active parts of vegetables, under the form of tinctures. The antiseptic power of alcohol renders it particularly valuable in preserving particular parts of the body as anatomical preparations. The steady and uniform heat which it gives during combustion, makes it a valuable material for burning in lamps.

ALCORAN, or ALKORAN, the name of a book held equally sacred among the Mahometans as the bible is among Christians.

The word *alcoran* properly signifies reading; a title given it by way of eminence, just as we call the Old and New Testament *Scriptures.*

That Mahomet was the author of the Alcoran is allowed both by Christians and the Mahometans themselves; only the latter are fully persuaded that it was revealed to him by the ministry of the angel Gabriel; whereas the former, with more reason, think it all his own invention, assisted by one Sergius, a Christian monk. The Alcoran is held not only of divine original, but eternal and uncreated, remaining, as some express it, in the very essence of God. The first transcript has been from everlasting by God's throne, written on a table of vast bigness, in which are also recorded the divine decrees, past and future. A copy from this table, in one volume, on paper, was sent down to the lowest heaven, in the month of Ramadan, on the night of power. From whence it was delivered out to Mahomet by parcels, some at Mecca, and some at Medina. Though he had the consolation of seeing the whole once a year, and in the last part of his life twice. Ten new chapters were delivered entire, the greater part only in separate periods, which were written down from time to time by the prophet's amanuensis, in this or that part, of this or the other chapter, as he directed. The first parcel that was revealed, was the five first verses of the ninety-sixth chapter, which the prophet received in a cave of Mount Harah, near Mecca.

The general aim of the Alcoran was, to unite the professors of the three different religions then followed in Arabia, Idolaters, Jews, and Christians, in the knowledge and worship of one God, under the sanction of certain laws, and the outward signs of ceremonies, partly of ancient, and partly of novel institution, enforced by the consideration of rewards and punishments, both temporal and eternal, and to bring all to the obedience of Mahomet, as the prophet and ambassador of God, who was to establish the true religion on earth, and be acknowledged chief pontiff in spiritual matters. The chief point therefore inculcated in the Alcoran is the unity of God, to restore which, the prophet confessed was the chief end of his mission. The rest is taken up in prescribing necessary laws and directions, frequent admonitions to moral and divine virtues, the worship and reverence of the Supreme Being, and resignation to his will.

As to the book itself, as it now stands, it is divided into 114 Suras, or chapters, which are again divided into smaller portions or verses. But besides these divisions, Mahometan writers farther divide it into 60 equal portions, called *hiz*, or *hazah*; each of which they subdivide into four parts.

After the title at the head of each chapter, except the ninth, is prefixed the formula, "In the name of the most merciful God," called by the Mahometans Bismallah, wherewith they constantly begin all their books and writings, as the distinguishing mark of their religion.

Twenty-nine of the chapters of the Alcoran have this further peculiarity, that there are certain letters of the alphabet prefixed to them. In some a single letter; in others, two or more. These letters are supposed, by the true believers, to conceal divers profound mysteries, the understanding whereof has been communicated to no man, their prophet excepted. Yet some have pretended to find their meaning, by supposing the letters to stand for so many words, expressing the names, attributes, and works of God; others explain these letters from the organ made use of in their pronunciation; others from their value in numbers.

There are seven principal editions of the Koran, two at Medina, one at Mecca, one at Cufa, one at Bassora, one in Syria, and the common or vulgate edition. The first contains 6000 verses; the second and fifth, 6214; the third, 6219; the fourth, 6236; the sixth, 6226; and the last, 6225; but the number of words and letters is the same in all, viz. 77,639 words, and 323,015 letters.

The Alcoran is allowed to be written with the utmost elegance and purity of language, in the dialect of the Koreishites, the most noble and polite of all the Arabians, but with some mixture of other dialects. It is the standard of the Arabic tongue, and as the orthodox believe, and are taught by the

book itself, inimitable by any human pen; and therefore insisted on as a permanent miracle, greater than that of raising the dead, and alone sufficient to convince the world of its divine original; and to this miracle did Mahomet himself chiefly appeal, for the confirmation of his mission, publicly challenging the most eloquent schoolmen in Arabia, to produce a single chapter comparable to it. A late ingenious and candid writer, who is a very good judge, allows the style of the Alcoran to be generally beautiful and fluent, especially where it imitates the prophetic manner, and scripture phrase; concise, and often obscure; adorned with bold figures, after the eastern taste; enlivened with florid and sententious expressions; and, in many places, especially where the majesty and attributes of God are described, sublime and magnificent.

To the pomp and harmony of expression some ascribe all the force and effect of the Alcoran; which they consider as a sort of music, equally fitted to ravish and amaze, with other species of that art. In this Mahomet succeeded so well, and so strangely captivated the minds of his audience, that several of his opponents thought it the effect of witchcraft and enchantment, as he himself complains.

So numerous are the commentaries on the Alcoran, that a catalogue of their bare titles would make a volume: we have a very elegant translation of it into English by Mr. Sale; who has added a preliminary discourse, with other occasional notes, which the curious may consult on this head.

Among Mahometans this book is held in the greatest reverence and esteem. The Mussulmen dare not touch it without being first washed, or legally purified; to prevent which an inscription is put on the cover or label: "Let none touch it but they who are clean." It is read with great care and respect. They swear by it, take omens from it on all weighty occasions, carry it with them to war, write sentences of it on their banners, adorn it with gold and precious stones, and do not suffer it to be in the possession of any who hold a different religion.

ALCYON, in natural history, a name given to the kingsfisher. See Alcedo.

ALCYONIUM, in natural history, a genus of Zoophytes, the characters of which are, that the animal grows in the form of a plant; the stem or root is fixed, fleshy, gelatinous, spongy, or coriaceous, with a cellular epidermis, penetrated with stellated pores, and shooting out tentaculated oviparous hydræ. There are 28 species. From some experiments made by Mr. Hatchett, and related by him in the Phil. Trans. on several of the species of alcyonium he was led to conclude, that they were all composed of a soft, flexible, membranaceous substance, slightly hardened by carbonate, mixed with a small portion of phospate of lime.

ALDEBARAN, in astronomy, a star of the first magnitude, called in English the Bull's eye, as making the eye of the constellation Taurus.

ALDER-*tree*, the English name of a genus of trees, called by botanists alnus. See Alnus.

ALDERMAN, in the British policy, a magistrate subordinate to the mayor of a city, or town-corporate.

The number of these magistrates is not limited, but is more or less according to the magnitude of the place. In London they are twenty-six; each having one of the wards of the city committed to his care. Their office is for life; so that when one of them dies or resigns, a ward-mote is called, who return two persons, one of whom the lord mayor and aldermen choose to supply the vacancy.

ALDROVANDA, in botany, a genus of the Pentantria Pentagynia class and order, of which there is only one species, viz. the A. vesiculosa, found in marshes in Italy and India, with bladders like utricularia, but in bunches.

ALE-*conner*, an officer in London, who inspects the measures of public houses. They are four in number, and chosen by the common-hall of the city.

Ale-*houses*, no licence to be granted to any person unless he produce a certificate of his good character, under the hands of the clergyman, churchwardens, &c. Penalties for selling without a licence, unless at fairs, 40*s*. for the first offence, 4*l*. for the second: no person can sell wine to be drank at his own house, who has not an ale licence.

Ale-*silver*, a tax paid yearly to the lord mayor of London, by all who sell ale within the city.

ALECTRA, in botany, a genus of the Didynamia Angiosperma class and order, of which there is a single species only, viz. A. capensis, a native of the Cape of Good Hope; found in grassy places near rivers; flowering in November and December.

ALEMBERT (John le Rond D') an eminent French mathematician and philosopher, and one of the brightest ornaments of the 18th century. He was perpetual

secretary to the French Academy of Sciences, and a member of most of the philosophical academies and societies of Europe.

D'Alembert was born at Paris, the 16th of November 1717, and derived the name of John le Rond, from that of the church near which, after his birth, he was exposed as a foundling. But his father, Destouches Canon, informed of this circumstance, listening to the voice of nature and duty, took measures for the proper education of his child, and for his future subsistence in a state of ease and independence. His mother, it is said, was a lady of rank, the celebrated Mademoiselle Tencin, sister to cardinal Tencin, archbishop of Lyons.

He received his first education among the Jansenists, in the College of the Four Nations, where he gave early signs of genius and capacity. In the first year of his philosophical studies, he composed a Commentary on the Epistle of St. Paul to the Romans. The Jansenists considered this production as an omen that portended to the party of Port-Royal, a restoration to some part of their former splendor, and hoped to find one day in d'Alembert a second Pascal. To render the resemblance more complete, they engaged their pupil in the study of the mathematics; but they soon perceived that his growing attachment to this science was likely to disappoint the hopes they had formed with respect to his future destination: they therefore endeavoured to divert him from the pursuit; but their endeavours were fruitless.

On his quitting the college, finding himself alone, and unconnected in the world, he sought an asylum in the house of his nurse, who was the wife of a glazier. He hoped that his fortune, though not ample, would enlarge the subsistence, and better the condition of her family, which was the only one that he could consider as his own. It was here, therefore, that he fixed his residence, resolving to apply himself entirely to the study of geometry. And here he lived, during the space of 30 years, with the greatest simplicity, discovering the augmentation of his means only by increasing displays of his beneficence, concealing his growing reputation and celebrity from these honest people, and making their plain and uncouth manners the subject of good-natured pleasantry and philosophical observation. His good nurse perceived his ardent activity; heard him mentioned as the writer of many books; and beheld him with a kind of compassion: "You will never," said she to him one day, "be any thing but a philosopher —and what is a philosopher?—a fool, who toils and plagues himself all his life, that people may talk of him when he is dead."

As D'Alembert's fortune did not far exceed the demands of necessity, his friends advised him to think of some profession that might enable him to increase it. He accordingly turned his views to the law, and took his degrees in that faculty, which he soon after abandoned, and applied himself to the study of medicine. Geometry, however, was always drawing him back to his former pursuits; so that after many ineffectual struggles to resist its attractions, he renounced all views of a lucrative profession, and gave himself up entirely to mathematics and poverty. In the year 1741 he was admitted a member of the Academy of Sciences; for which distinguished literary promotion, at so early an age (24), he had prepared the way by correcting the errors of the "Analyse Demontrée" of Reyneau, which was highly esteemed in France in the line of analytics He afterwards set himself to examine, with attention and assiduity, what must be the motion and path of a body, which passes from one fluid into another denser fluid, in a direction oblique to the surface between the two fluids. Two years after his election to a place in the academy, he published his "Treatise on Dynamics." The new principle developed in this treatise consisted in establishing an equality, at each instant, between the changes that the motion of a body has undergone, and the forces or powers which have been employed to produce them; or, to express the same thing otherwise, in separating into two parts the action of the moving powers, and considering the one as producing alone the motion of the body, in the second instant, and the other as employed to destroy that which it had in the first.

So early as the year 1744, D'Alembert had applied this principle to the theory of the equilibrium, and the motion of fluids: and all the problems before resolved in physics, became in some measure its corollaries. The discovery of this new principle was followed by that of a new calculus, the first essays of which were published in a "Discourse on the General Theory of the Winds;" to this the prize-medal was adjudged by the Academy of Berlin, in the year 1746, which proved a new and brilliant addition to the fame of D'Alembert. This new calculus of "Partial Differences" he applied, the year following, to the problem of vibrating chords, the resolution of which, as well as the theory

of the oscillations of the air, and the propagation of sound, had been but imperfectly given by the mathematicians who preceded him; and these were his masters or his rivals. In the year 1749 he furnished a method of applying his principle to the motion of any body of a given figure. He also resolved the problem of the precession of the equinoxes; determining its quantity, and explaining the phenomenon of the nutation of the terrestrial axis discovered by Dr. Bradley.

In 1752, D'Alembert published a treatise on the "Resistance of Fluids," to which he gave the modest title of an "Essay;" though it contains a multitude of original ideas and new observations. About the same time he published, in the Memoirs of the Academy of Berlin, "Researches concerning the Integral Calculus," which is greatly indebted to him for the rapid progress it has made in the present century.

While the studies of D'Alembert were confined to mere mathematics, he was little known or celebrated in his native country. His connections were limited to a small society of select friends. But his cheerful conversation, his smart and lively sallies, a happy method at telling a story, a singular mixture of malice of speech with goodness of heart, and of delicacy of wit with simplicity of manners, rendering him a pleasing and interesting companion, his company began to be much sought after in the fashionable circles. His reputation at length made its way to the throne, and rendered him the object of royal attention and beneficence. The consequence was a pension from government, which he owed to the friendship of count D'Argenson.

But the tranquillity of D'Alembert was abated when his fame grew more extensive, and when it was known beyond the circle of his friends, that a fine and enlightened taste for literature and philosophy accompanied his mathematical genius. Our author's eulogist ascribes to envy, detraction, &c. all the opposition and censure that D'Alembert met with on account of the famous Encyclopédie, or Dictionary of Arts and Sciences, in conjunction with Diderot. None surely will refuse the well-deserved tribute of applause to the eminent displays of genius, judgment, and true literary taste, with which D'Alembert has enriched that great work. Among others, the Preliminary Discourse he has prefixed to it, concerning the rise, progress, connections, and affinities of all the branches of human knowledge, is perhaps one of the most capital productions the philosophy of the age can boast of.

Some time after this, D'Alembert published his "Philosophical, Historical, and Philological Miscellanies." These were followed by the "Memoirs of Christiana, Queen of Sweden;" in which D'Alembert shewed that he was acquainted with the natural rights of mankind, and was bold enough to assert them. His "Essay on the Intercourse of Men of Letters with Persons high in Rank and Office," wounded the former to the quick, as it exposed to the eyes of the public the ignominy of those servile chains which they feared to shake off, or were proud to wear. A lady of the court hearing one day the author accused of having exaggerated the despotism of the great, and the submission they require, answered slyly, "If he had consulted me, I would have told him still more of the matter."

D'Alembert gave elegant specimens of his literary abilities in his translations of some select pieces of Tacitus. But these occupations did not divert him from his mathematical studies: for about the same time he enriched the Encyclopédie with a multitude of excellent articles in that line, and composed his "Researches on several Important Points of the System of the World," in which he carried to a higher degree of perfection the solution of the problem concerning the perturbations of the planets, that had several years before been presented to the Academy. In 1759 he published his "Elements of Philosophy:" a work much extolled as remarkable for its precision and perspicuity. The resentment that was kindled (and the disputes that followed it) by the article Geneva, inserted in the Encyclopédie, are well known. D'Alembert did not leave this field of controversy with flying colours. Voltaire was an auxiliary in the contest: but as he had no reputation to lose, in point of candour and decency; and as he weakened the blows of his enemies, by throwing both them and the spectators into fits of laughter, the issue of the war gave him little uneasiness. It fell more heavily on D'Alembert; and exposed him, even at home, to much contradiction and opposition. It was on this occasion that the late King of Prussia offered him an honourable asylum at his court, and the office of president of his academy: and the king was not offended at D'Alembert's refusal of these distinctions, but cultivated an intimate friendship with him during the rest of his life. He had refused, some time before this, a proposal made by the Empress

of Russia to entrust him with the education of the Grand Duke;—a proposal accompanied with all the flattering offers that could tempt a man, ambitious of titles, or desirous of making an ample fortune: but the objects of his ambition were tranquillity and study. In the year 1765, he published his "Dissertation on the Destruction of the Jesuits." This piece drew upon him a swarm of adversaries, who only confirmed the merit and credit of his work by their manner of attacking it.

Beside the works already mentioned, he published nine volumes of memoirs and treatises, under the title of "Opuscules;" in which he has resolved a multitude of problems relating to astronomy, mathematics, and natural philosophy; of which his panegyrist, Condorcet, gives a particular account, more especially of those which exhibit new subjects, or new methods of investigation. He published also "Elements of Music;" and rendered, at length, the system of Rameau intelligible; but he did not think the mathematical theory of the sonorous body sufficient to account for the rules of that art. In the year 1772 he was chosen Secretary to the French Academy of Sciences. He formed, soon after this preferment, the design of writing the lives of all the deceased academicians, from 1700 to 1772; and in the space of three years he executed this design, by composing 70 eulogies.

The correspondence which D'Alembert held with eminent literary characters, and his constant intercourse with learned men of all nations, together with his great influence in the academy, concurred to give him a distinguished importance above most of his countrymen. By some, who were jealous of his reputation, he was denominated the Mazarin of literature; but there seems now no doubt, but that his influence was obtained by his great talents and learning, rather than by artful management and supple address. He was a decided and open enemy to superstition and priestcraft. Without inquiring into the merits of Christianity, he concluded that the religion taught in France, was that which believers in general regarded as the true doctrine, and which he rejected as a fable, unworthy the attention of the philosopher. There is no reason to think that he ever studied the foundations on which natural and revealed religion were built; and it is certain that he adopted a system of deified nature, which bereaves the world of a designing cause, and presiding intelligence. He was zealous even in propagating the opinions which he adopted, and might be regarded as an apostle of atheism. The eccentricity of his opinions did not destroy the moral virtues of his heart. A love of truth, and a zeal for the progress of real science and liberty, formed the basis of his character: strict probity, a noble disinterestedness, and an habitual desire of being useful, were its distinguishing features. To the young who possessed talents and genius he was a patron and instructor: to the poor and oppressed he became a firm and generous friend: to those who had shewn him kindness he never ceased to be grateful; a sure evidence of a great mind. To two ministers who had befriended him in their prosperity, he dedicated works when they were in disgrace with the court. An instance of a kind, a grateful disposition, was displayed by D'Alembert in early life. His mother, who had infamously disowned and abandoned him, hearing of the greatness of his talents, and of the promise which he gave of future celebrity, obtained an interview, and laid claim to the character of a parent. "What do I hear," said the indignant youth, "you are the mother-in-law, the glazier's wife is my true mother:" for her, indeed, he never ceased to testify the affection and gratitude of a child; and under her roof he resided, as we have seen, many years, till an alarming illness made it necessary for him to remove to a more airy lodging. D'Alembert maintained his high rank and reputation among mathematicians and philosophers till his death, in October 1783. His loss was deplored by survivors of every country, but his particular friends and associates exhibited, on the occasion, every mark of grief, which real and unaffected sorrow can alone supply for undissembled worth.

ALEMBIC, in chemistry, a vessel usually made of glass or copper, formerly used for distillation. The bottom, in which the substance to be distilled is put, is called the *cucurbit;* the upper part is called the head, the beak of which is fitted into the neck of the receiver. Retorts, and the common worm-still are now more generally employed. See CHEMISTRY, DISTILLATION, &c.

ALETRIS, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Liliæ or Liliaceæ, of which there are nine species; A. farinosa, or American aletris, used by the natives in coughs, and in the pleurisy. Some of the species are natives of the Cape of Good Hope; others are found natural in Ceylon and Guinea. The A. zeylanica, or Ceylon aloe,

is common in gardens where exotic plants are preserved. A. guianensis, or Guinea aloe, when in flower, seldom continues in beauty more than two or three days, and never produces seeds in England. The Ceylon, Guinea, and sweet-scented species, are too tender to live through the winter in England, unless in a warm stove; and they will not produce flowers if the plants are not plunged into a tan-bed. The creeping roots of the Ceylon and Guinea sorts send up many heads, which should be cut off in June, and after having been laid in the stove a fortnight, that the wounded part may heal; they should be planted in small pots of light sandy earth, plunged into a moderate hot-bed, and treated like other tender succulent plants, and be never set abroad in summer.

ALEURITES, in botany, a genus of Monœcia Monadelphia class and order, of the natural order of Tricoccæ. The flowers are male and female; the calyx of the male is a perianthium; the corollas five petals; the nectary has five-cornered scales; the stamens are numerous filaments; the anthers roundish. The female flowers are few, the calyx, corolla, and nectarium, as in the male, but larger. There are two seeds with a double bark. Only one species, a tree in the islands of the South Seas.

ALEXANDRIAN *copy of the New Testament*, preserved in the British Museum, is referred to as an object of curiosity, as well as of considerable importance, to persons who study the scriptures critically. It consists of four large quarto, or rather folio volumes, containing the whole bible in Greek, including the Old and New Testament, with the Apocrypha, and some smaller pieces, but not quite complete. It was placed in the British Museum in 1758; and had been a present to Charles I. from Cyrillus Lucaris, a native of Crete, and patriarch of Constantinople, by Sir Thomas Rowe, ambassador from England to the Grand Seignior in the year 1628. Cyrillus brought it with him from Alexandria, where it was probably written. It is said to have been written by Thecla, a noble Egyptian lady, about thirteen hundred years ago. In the New Testament there is wanting the beginning as far as Matt. xxv. 6; likewise from John vi. 50, to viii. 52; and from 2 Cor. iv. 19, to xii. 7. It has neither accents nor marks of aspiration; it is written with capital, or, as they are called, *uncial* letters, and there are no intervals between the words, but the sense of a passage is sometimes terminated by a point, and sometimes by a vacant space. Dr. Woride published this valuable work in 1786, with types cast for the purpose, line for line, precisely like the original MS: the copy has been examined with the greatest care, and it is found to be so perfect a resemblance of the original, that it may supply its place. The authenticity, antiquity, &c. of this MS. is briefly, but ably discussed in Rees's New Cyclopedia. Vol. I. p. ii.

ALGÆ, in botany, an order or division of the Cryptogamia class of plants. It is one of the seven families or natural tribes, into which the vegetable kingdom is distributed, in the Philosophia Botanica of Linnæus; the 57th order of his fragments of a natural method.

The plants belonging to this order are described as having their root, leaf, and stem entire, or all one. The whole of the sea-weeds, and various other aquatic plants, are comprehended under this division. From their admitting of little distinction of root, leaf, or stem; and the parts of their flowers being equally incapable of description; the genera are distinguished by the situation of what is supposed to be the flowers or seeds, or by the resemblance which the whole plant bears to some other substance. The parts of fructification are either found in saucers or tubercules, as in lichens; in hollow bladders, as in the fuci; or dispersed through the whole substance of the plants, as in the ulvæ. The substance of the plants has much variety; it is flesh-like or leather-like, membranaceous or fibrous, jelly-like or horn-like, or it has the resemblance of a calcareous earthy matter.

Lamarck distributes the algæ into three sections: the first comprehends all those plants whose fructification is not apparent or seems doubtful. These commonly live in water, or upon moist bodies, and are membranous, gelatinous, or filamentous. To this section he refers the byssi, conferva, ulva, tremella, and varec. The plants of the second section are distinguished by their apparent fructification, though it be little known, and they are formed of parts which have no particular and sensible opening or explosion, at any determined period; their substance is ordinarily crustaceous or coriaceous. They include the tassella, ceratosperma, and lichen. The third section comprehends plants which have their fructification very apparent, and distinguished by constituent parts which open at a certain period of maturity, for the escape of the fecundating dust or seeds. These plants

are more herbaceous, as to both their substance and their colour, than those of the other two sections, and are more nearly related to the mosses, from which they do not essentially differ. Their flowers are often contained in articulated and very elastic filaments. To this section are referred the riccia, blasia, anthoceros, targiona, hepatica, and junger-manna. In the Linnæan system the algæ are divided into two classes, viz. the terrestres and aquaticæ. The former include the anthoceros, blasia, riccia, lichen, and byssus; and the latter are the ulva, fucus, and conferva. The fructification of the algæ, and particularly of those called aquaticæ, is denominated by a judicious botanist, the opprobrium botanicorum.

ALGAROTH. See ANTIMONY.

ALGEBRA, a general method of resolving mathematical problems, by means of equations; or, it is a method of computation by symbols, which have been invented for expressing the quantities that are the objects of this science, and also their mutual relation and dependence. These quantities might, probably, in the infancy of the science, be denoted by their names at full length; these, being found inconvenient, were succeeded by abbreviations, or by their mere initials; and, at length, certain letters of the alphabet were adopted as general representations of all quantities; other symbols or signs were introduced to prevent circumlocution, and to facilitate the comparison of various quantities with one another; and, in consequence of the use of letters or species, and other general symbols, or indeterminate quantities, algebra obtained the appellation of specious, literal, and universal arithmetic. The origin of algebra, like that of other sciences of ancient date and gradual progress, is not easily ascertained. The most ancient treatise on that part of analytics, which is properly called algebra, now extant, is that of Diophantus, a Greek author of Alexandria, who flourished about the year of our Lord 350, and who wrote 13 books, though only six of them are preserved, which were printed together with a single imperfect book on multangular numbers, in a Latin translation by Xylander, in 1575, and afterwards in Greek and Latin, with a Comment, in 1621 and 1670, by Gaspar Bachet, and M. Fermat, Tolosæ, fol. These books do not contain a treatise on the elementary parts of algebra, but merely collections of some difficult questions relating to square and cube numbers, and other curious properties of numbers, with their solutions. Algebra, however, seems not to have been wholly unknown to the ancient mathematicians, long before the age of Diophantus. We observe the traces and effects of it in many places, though it seems as if they had intentionally concealed it. Something of it appears in Euclid, or at least in Theon upon Euclid, who observes that Plato had begun to teach it And there are other instances of it in Pappus, and more in Archimedes and Appollonius. But it should be observed, that the analysis used by these authors is rather geometrical than algebraical; this appears from the examples that occur in their works; and, therefore, Diophantus is the first and only author among the Greeks who has treated professedly of algebra. Our knowledge of the science was derived, not from Diophantus, but from the Moors or Arabians; but whether the Greeks or Arabians were the inventors of it has been a subject of dispute. It is probable, however, that it is much more ancient than Diophantus, because his treatise seems to refer to works similar and prior to his own.

Algebra is a peculiar kind of arithmetic, which takes the quantity sought, whether it be a number, or a line, or any other quantity, as if it were granted; and by means of one or more quantities given, proceeds by a train of deductions, till the quantity at first only supposed to be known, or at least some power of it, is found to be equal to some quantity or quantities which are known, and consequently itself is known.

Algebra is of two kinds, numeral and literal.

ALGEBRA, *numeral* or *vulgar*, is that which is chiefly concerned in the resolution of arithmetical questions. In this, the quantity sought is represented by some letter or character; but all the given quantities are expressed by numbers. Such is the algebra of the more ancient authors, as Diophantus, Paciolus, Stifelius, &c. This is thought by some to have been an introduction to the art of keeping merchants' accounts, by double entry.

ALGEBRA, *specious* or *literal*, or the new algebra, is that in which all the quantities, known and unknown, are expressed or represented by their species, or letters of the alphabet. There are instances of this method from Cardan, and others about his time; but it was more generally introduced and used by Vieta. Dr. Wallis apprehends that the name of specious arithmetic, applied to algebra, is given to it with a reference to the sense in which the Civilians use

the word species. Thus, they use the names Titius, Sempronius, Caius, and the like, to represent indefinitely any person in such circumstances; and cases so propounded, they call species. Vieta, accustomed to the language of the civil law, gave, as Wallis supposes, the name of species to the letters A, B, C, &c. which he used to represent indefinitely any number or quantity, so circumstanced as the occasion required. This mode of expression frees the memory and imagination from that stress or effort, which is required to keep several matters, necessary for the discovery of the truth investigated, present to the mind; for which reason this art may be properly denominated metaphysical geometry. Specious algebra is not like the numeral, confined to certain kinds of problems; but serves universally for the investigation or invention of theorems, as well as the solution and demonstration of all kinds of problems, both arithmetical and geometrical. The letters used in algebra, do each of them, separately, represent either lines or numbers, as the problem is either arithmetical or geometrical; and together, they represent planes, solids, and powers, more or less high, as the letters are in a greater or less number. For instance, if there be two letters, ab, they represent a rectangle, whose two sides are expressed, one by the letter a, and the other by b; so that by their mutual multiplication they produce the plane ab. Where the same letter is repeated twice, as aa, they denote a square. Three letters abc, represent a solid or a rectangular parallelepiped, whose three dimensions are expressed by the three letters abc; the length by a, the breadth by b, and the depth by c; so that by their mutual multiplication, they produce the solid abc. As the multiplication of dimensions is expressed by the multiplication of letters, and as the number of these may be so great as to become incommodious, the method is only to write down the root, and on the right hand to write the index of the power, that is, the number of letters of which the quantity to be expressed consists; as a^2, a^3, a^4, &c. the last of which signifies as much as a multiplied four times into itself; and so of the rest. But as it is necessary, before any progress can be made in the science of algebra, to understand the method of notation, we shall here give a general view of it. In algebra, as we have already stated, every quantity whether it be known or given, or unknown or required, is usually represented by some letter of the alphabet; and the given quantities are commonly denoted by the initial letters, a, b, c, d, &c. and the unknown ones by the final letters, u, w, x, y, z. These quantities are connected together by certain signs or symbols, which serve to shew their mutual relation, and at the same time to simplify the science, and to reduce its operations into a less compass. Accordingly the sign $+$, plus, or more, signifies that the quantity to which it is prefixed is to be added, and it is called a positive or affirmative quantity. Thus, $a+b$ expresses the sum of the two quantities a and b, so that if a were 5, and b, 3, $a+b$ would be $5+3$, or 8. If a quantity have no sign, $+$, plus, is understood, and the quantity is affirmative or positive. The sign $-$, minus, or less, denotes that the quantity which it precedes is to be subtracted, and it is called a negative quantity. Thus $a-b$ expresses the difference of a and b; so that a being 5, and b, 3, $a-b$ or $5-3$ would be equal to 2. If more quantities than two were connected by these signs, the sum of those with the sign $-$ must be subtracted from the sum of those with the sign $+$. Thus, $a+b-c-d$ represents the quantity which would remain, when c and d are taken from a and b. So that if a were 7, b, 6, c, 5, and d, 3, $a+b-c-d$, or $7+6-5-3$, or $13-8$, would be equal to 5. If two quantities are connected by the sign $\backsim$, as $a \backsim b$, this mode of expression represents the difference of a and b, when it is not known which of them is the greatest. The sign $\times$ signifies that the quantities between which it stands are to be multiplied together, or it represents their product. Thus, $a \times b$ expresses the product of a and b; $a \times b \times c$ denotes the product of a, b, and c; $a+b \times c$ denotes the product of the compound quantity $a+b$ by the simple quantity c; and $\overline{a+b+c} \times \overline{a-b+c} \times \overline{a+b}$ represents the product of the three compound quantities, multiplied continually into one another; so that if a were 5, b, 4, and c, 3, then would $\overline{a+b+c} \times \overline{a-b+c} \times \overline{a+c}$ be $12 \times 4 \times 8$, or 384. The line connecting the simple quantities and forming a compound one, placed over them, is called a vinculum. Quantities that are joined together without any intermediate sign form a product; thus ab is the same with $a \times b$, and abc the same with $a \times b \times c$. When a quantity is multiplied into itself, or raised to any power, the usual mode of expression is to draw a line over the quantity, and to place the number denoting the power at the

end of it, which number is called the index or exponent. Thus, $\overline{a+b}|^2$ denotes the same as $\overline{a+b} \times \overline{a+b}$ or second power, or square, of $\overline{a+b}$ considered as one quantity; and $\overline{a+b}|^3$ denotes the same as $\overline{a+b} \times \overline{a+b} \times \overline{a+b}$, or the third power, or cube, of $a+b$. In expressing the powers of quantities represented by single letters, the line over the top is usually omitted; thus, a^2 is the same as $a.a$ or $a \times a$, and b^3 the same as $b\,b\,b$ or $b \times b \times b$, and $a^2\,b^3$, the same as $aa \times b\,b\,b$ or $a \times a \times b \times b \times b$. The full point . and the word into, are sometimes used instead of $\times$ as the sign of multiplication. Thus, $\overline{a+b}\,.\,\overline{a+c}$, and $\overline{a+b}$ into $\overline{a+c}$, signify the same thing as $\overline{a+b} \times \overline{a+c}$, or the product of $\overline{a+b}$ by $\overline{a+c}$. The sign $\div$ is the sign of division, as it denotes that the quantity preceding it is to be divided by the succeeding quantity. Thus, $c \div b$ signifies that c is to be divided by b; and $\overline{a+b} \div \overline{a+c}$, that $\overline{a+b}$ is to be divided by $\overline{a+c}$. The mark) is sometimes used as a note of division; thus $a+b)\,a\,b$, denotes that $a\,b$ is to be divided by $a+b$. But the division of algebraic quantities is most commonly expressed by placing the divisor under the dividend with a line between them, like a vulgar fraction. Thus, $\frac{c}{b}$ represents the quantity arising by dividing c by b, or the quotient, and $\frac{a+b}{a+c}$ represents the quotient of $a+b$ divided by $a+c$. Quantities thus expressed are called algebraic fractions.

The sign $\sqrt{}$ expresses the square root of any quantity to which it is prefixed; thus $\sqrt{25}$ signifies the square root of 25, or 5, because 5×5 is 25; and $\sqrt{a\,b}$ denotes the square root of $a\,b$; and $\sqrt{\frac{a\,b+b\,c}{d}}$ denotes the square root of $\frac{a\,b+b\,c}{d}$, or of the quantity arising from the division of $a\,b + b\,c$ by d; but $\frac{a\,b+b\,c}{d}$, which has the separating line drawn under $\sqrt{}$, signifies that the square root of $a\,b+b\,c$ is to be first taken, and afterwards divided by d; so that if a were 2, b, 6, c, 4, and d, 9, $\frac{\sqrt{a\,b+b\,c}}{d}$ would be $\frac{\sqrt{36}}{9}$ or $\frac{6}{9}$; but $\sqrt{\frac{a\,b+b\,c}{d}}$ would be $\sqrt{\frac{36}{9}}$ or $\sqrt{4}$, which is 2. The sign $\sqrt{}$ with a figure over it is used to express the cubic or biquadratic root, &c. of any quantity; thus $\sqrt[3]{64}$ represents the cube root of 64, or 4, because $4 \times 4 \times 4$ is 64; and $\sqrt[3]{a\,b+c\,d}$ the cube root of $a\,b+c\,d$. In like manner $\sqrt[4]{16}$ denotes the biquadratic root of 16, or 2, because $2 \times 2 \times 2 \times 2$ is 16, and $\sqrt[4]{a\,b+c\,d}$ denotes the biquadratic root of $a\,b+c\,d$; and so of others. Quantities thus expressed are called radical quantities, or surds; of which those, consisting of one term only, as $\sqrt{a}$ and $\sqrt{a\,b}$, are called simple surds; and those consisting of several terms or numbers, as $\sqrt{a^2-b^2}$ and $\sqrt[3]{a^2-b+b\,c}$ are denominated compound surds. Another commodious method of expressing radical quantities is that which denotes the root by a vulgar fraction, placed at the end of a line drawn over the quantity given. In this notation, the square root is expressed by $\frac{1}{2}$, the cube root by $\frac{1}{3}$, the biquadratic root by $\frac{1}{4}$, &c. Thus $\overline{a}|^{\frac{1}{2}}$ expresses the same quantity with $\sqrt{a}$, i.e. the square root of a, and $\overline{a^2+a\,b}|^{\frac{1}{3}}$ the same as $\sqrt[3]{a^2+a\,b}$, i.e. the cube root of $a^2+a\,b$; and $\overline{a}|^{\frac{2}{3}}$ denotes the cube root of the square of a, or the square of the cube root of a; and $\overline{a+z}|^{\frac{7}{4}}$ the seventh power of the biquadratic root of $a+z$; and so of others; $\overline{a^2}|^{\frac{1}{2}}$ is a, $\overline{a^3}|^{\frac{1}{3}}$ is a, &c. When the root of a quantity represented by a simple letter is to be expressed, the line over it may be omitted; so that $a^{\frac{1}{2}}$ signifies the same as $\overline{a}|^{\frac{1}{2}}$, and $b^{\frac{1}{3}}$ the same as $\overline{b}|^{\frac{1}{3}}$ or $\sqrt[3]{b}$. Quantities that have no radical sign ($\sqrt{}$) or index annexed to them, are called rational quantities. The sign $=$, called the sign of equality, signifies that the quantities between which it occurs are equal. Thus $2+3=5$, shews that 2 plus 3 is equal to 5; and $x=a-b$ shews that x is equal to the difference of a and b. The mark :: signifies that the quantities between which it stands are proportional. As $a:b::c:d$ denotes that a is in the same proportion to b as c is to d; or that if a be twice, three, or four times, &c. as great as b, c will be twice, thrice, or four times, &c. as great as d. When any quantity is to be taken more than once, the number, which shews how many times it is to

be taken must be prefixed; thus $5a$ denotes that the quantity a is to be taken 5 times, and $3bc$ represents three times bc, and $7\sqrt{a^2+b^2}$ denotes that $\sqrt{a^2+b^2}$ is to be taken 7 times, &c. The numbers thus prefixed are called co-efficients; and if a quantity have no co-efficient, unit is understood, and it is to be taken only once. Similar or like quantities are those that are expressed by the same letters under the same powers, or which differ only in their co-efficients; thus, $3bc$, $5bc$, and $8bc$, are like quantities, and so are the radicals $2\sqrt{\frac{b+c}{a}}$ and $7\sqrt{\frac{b+c}{a}}$. But unlike quantities are those which are expressed by different letters, or by the same letters with different powers, as $2ab$, $5ab^2$, and $3a^2b$. When a quantity is expressed by a single letter, or by several single letters multiplied together, without any intervening sign, as a, or $2ab$, it is called a simple quantity. But the quantity which consists of two or more such simple quantities, connected by the signs $+$ or $-$, is called a compound quantity; thus, $a - 2ab + 5abc$ is a compound quantity; and the simple quantities a, $2ab$, $5abc$, are called its terms or members. If a compound quantity consist of two terms, it is called a binomial; of three terms, a trinomial; of four terms, a quadrinomial, &c. of many terms, a multinomial. If one of the terms of a binomial be negative, the quantity is called a residual quantity. The reciprocal of any quantity is that quantity inverted, or unity divided by it; thus $\frac{a}{b}$ is the reciprocal of $\frac{b}{a}$, and $\frac{1}{a}$ is the reciprocal of a. The letters by which any simple quantity is expressed may be ranged at pleasure, and yet retain the same signification; thus ab and ba are the same quantity, the product of a and b being the same with that of b by a. The several terms of which any compound quantity consists may be disposed in any order at pleasure, provided they retain their proper signs. Thus, $a - 2ab + 5a^2b$ may be written $a + 5a^2b - 2ab$, or $-2ab + a + 5a^2b$, for all these represent the same thing or the quantity which remains, when from the sum of a and $5a^2b$, the quantity $2ab$ is deducted.

Axioms. 1. If equal quantities be added to equal quantities, the sums will be equal.

2. If equal quantities be taken from equal quantities, the remainders will be equal.

3. If equal quantities be multiplied by the same, or equal quantities, the products will be equal.

4. If equal quantities be divided by the same, or equal quantities, the quotients will be equal.

5. If the same quantity be added to and subtracted from another, the value of the latter will not be altered.

6. If a quantity be both multiplied and divided by another, its value will not be altered.

ADDITION OF ALGEBRAICAL QUANTITIES.

The addition of algebraical quantities is performed by connecting those that are unlike *with their proper signs, and collecting those that are* similar *into one sum.*

Add together the following *unlike* quantities:

$$\begin{array}{ll} \text{Ex. 1.} & ax \\ & -bu \\ & +3z \\ & -2y \\ \hline \text{Ans.} & ax - bu + 3z - 2y \end{array}$$

$$\begin{array}{ll} \text{Ex. 2.} & -a+b \\ & +3z-x \\ & -4y+3c \\ \hline \text{Ans.} & -a+b+3c-x-4y+3z \end{array}$$

It is immaterial in what order the quantities are set down, if we take care to prefix to each its proper sign.

When any terms are *similar*, they may be incorporated, and the general expression for the sum shortened.

1. When *similar* quantities have the *same* sign, their sum is found by taking the sum of the co-efficients with that sign, and annexing the common letters.

$$\begin{array}{ll} \text{Ex. 3.} & 4a-5b \\ & 2a-6b \\ & 9a-3b \\ \hline \text{Ans.} & 15a-14b \end{array}$$

$$\begin{array}{ll} \text{Ex. 4.} & 4a^2c-10bde \\ & 6a^2c-9bde \\ & 11a^2c-3bde \\ \hline \text{Ans.} & 21a^2c-22bde \end{array}$$

The reason is evident; $4a$ to be added, together with $2a$ and $9a$ to be added, makes $15a$ to be added; and $5b$ to be subtracted,

together with 6 b and 3 a to be subtracted, is 14 b to be subtracted.

2. If *similar* quantities have *different* signs, their sum is found by taking the difference of the co-efficients with the sign of the greater, and annexing the common letters as before.

$$\begin{array}{ll} \text{Ex. 5.} & 7a+3b \\ & -5a-9b \\ \hline \text{Ans.} & 2a-6b \end{array}$$

$$\begin{array}{ll} \text{Ex. 6.} & 6a+4b+\ \ 9c \\ & -9a+3b+16c \\ & +12a-7b-20c \\ \hline \text{Ans.} & 9a\ \ *\ \ +\ \ 5c \end{array}$$

In the first part of the operation we have 7 times a to add, and 5 times a to take away; therefore, upon the whole, we have 2 a to add. In the latter part, we have 3 times b to add, and 9 times b to take away; *i. e.* we have, upon the whole, 6 times b to take away: and thus the sum of all the quantities is $2a-6b$.

If several similar quantities are to be added together, some with positive and some with negative signs, take the difference between the sum of the positive and the sum of the negative co-efficients, prefix the sign of the greater sum, and annex the common letters.

$$\begin{array}{ll} \text{Ex. 7.} & 3a^2+4bc-\ \ e^2+10x-25 \\ & -5a^2+6bc+2e^2-15x+44 \\ & -4a^2-9bc-10e^2+21x-90 \\ \hline \text{Ans.} & -6a^2+\ bc-\ 9e^2+16x-71 \end{array}$$

$$\begin{array}{ll} \text{Ex. 8.} & 4ac-15bd+ex\ \ \ \ -ax \\ & 11ac+7b^2-19ex+4ax \\ & -41a^2+6bd-7de-2ax \\ \hline \text{Ans.} & 15ac-41a^2-9bd+7b^2-18ex-7de-ax \end{array}$$

$$\begin{array}{ll} \text{Ex. 9.} & px^3-qx^2-rx \\ & ax^3-bx^2-x \\ \hline \text{Ans.} & \overline{p+a}\,.\,x^3-\overline{q+b}\,.\,x^2-\overline{r+1}\,.\,x \end{array}$$

In this example, the co-efficients of x and its powers are united; $\overline{p+a}\,.\,x^3=px^3+ax^3$; also $-\overline{q+b}\,.\,x^2=-qx^2-bx^2$, because the negative sign affects the whole quantity under the vinculum; and $-\overline{r-1}\,.\,x=-rx-x$.

SUBTRACTION.

Subtraction, or the taking away of one quantity from another, is performed by changing the sign of the quantity to be subtracted, and then adding it to the other by the rules laid down in the last article.

Ex. 1. From $2bx$ take cy, and the difference is properly represented by $2bx-cy$; because the — prefixed to cy shews that it is to be subtracted from the other; and $2bx-cy$ is the sum of $2bx$ and $-cy$.

Ex. 2. Again, from $2bx$ take $-cy$, and the difference is $2bx+cy$; because $2bx=2bx+cy-cy$, take away $-cy$ from these equal quantities, and the differences will be equal; *i. e.* the difference between $2bx$ and $-cy$ is $2bx+cy$, the quantity which arises from adding $+cy$ to $2bx$.

$$\begin{array}{rl} \text{Ex. 3. From} & a+b \\ \text{take} & a-b \\ \hline \text{Ans.} & *+2b \end{array}$$

$$\begin{array}{rl} \text{Ex. 4. From} & 6a-12b \\ \text{take} & -5a-10b \\ \hline \text{Ans.} & 11a-2b \end{array}$$

$$\begin{array}{rl} \text{Ex. 5. From} & 5a^2+4ab-6xy \\ \text{take} & 11a^2+6ab-4xy \\ \hline \text{Ans.} & -6a^2-2ab-2xy \end{array}$$

$$\begin{array}{rl} \text{Ex. 6. From} & 4a-3b+6c-11 \\ \text{take} & 10x+\ a-15-2y \\ \hline \text{Ans.} & 3a-3b+6c-10x+2y+4 \end{array}$$

$$\begin{array}{rl} \text{Ex. 7. From} & ax^3-bx^2+x \\ \text{take} & px^3-qx^2+rx \\ \hline \text{Ans.} & \overline{a-p}\,.\,x^3-\overline{b-q}\,.\,x^2+\overline{1-r}\,.\,x \end{array}$$

In this example the co-efficients are united; $\overline{a-p}\,.\,x^3$ is equal to ax^3-px^3; $-\overline{b-q}\,.\,x^2$ is equal to $-bx^2+qx^2$; and $\overline{1-r}\,.\,x=x-rx$.

MULTIPLICATION.

The multiplication of simple algebraical quantities must be represented according to the notation already pointed out.

Thus, $a\times b$, or ab, represents the product of a multiplied by b; abc, the product of the three quantities a, b, and c.

It is also indifferent in what order they are placed, $a\times b$ and $b\times a$ being equal.

To determine the *sign* of the product, observe the following rule:

If the multiplier and multiplicand have the

same *sign, the product is positive; if they have* different *signs, it is negative.*

1. $+a \times +b = +ab$; because in this case a is to be taken positively b times; therefore the product ab must be positive.

2. $-a \times +b = -ab$; because $-a$ is to be taben b times; that is, we must take $-ab$.

3. $+a \times -b = -ab$; for a quantity is said to be multiplied by a negative number $-b$, if it be subtracted b times; and a subtracted b times is $-ab$.

4. $-a \times -b = +ab$. Here $-a$ is to be subtracted b times; that is, $-ab$ is to be subtracted; but subtracting $-ab$ is the same as adding $+ab$; therefore we have to add $+ab$.

The 2[d] and 4[th] cases may be thus proved; $a - a = o$, multiply both sides by b, and ab together with $-a \times b$ must be equal to $b \times o$, or nothing; therefore $-a$ multiplied by b must give $-ab$, a quantity which when added to ab makes the sum nothing.

Again, $a - a = o$; multiply both sides by $-b$, then $-ab$ together with $-a \times -b$ must be $= o$; therefore $-a \times -b = +ab$.

If the quantities to be multiplied have co-efficients, these must be multiplied together as in common arithmetic; the sign and the literal product being determined by the preceding rules.

Thus, $3a \times 5b = 15ab$; because $3 \times a \times 5 \times b = 3 \times 5 \times a \times b = 15ab$; $4x \times -11y = -44xy$; $-9b \times -5c = +45bc$; $-6d \times 4m = -24md$.

The powers of the same quantity are multiplied together by *adding* the indices; thus, $a^2 \times a^3 = a^5$; for $aa \times aaa = aaaaa$. In the same manner, $a^m \times a^n = a^{m+n}$; and $-3a^2x^3 \times 5axy^2 = -15a^3x^4y^2$.

If the multiplier or multiplicand consist of several terms, each term of the latter must be multiplied by every term of the former, and the sum of all the products taken, for the whole product of the two quantities.

$$\begin{array}{ll} \text{Ex. 1. Mult.} & a+b+x \\ \text{by} & c+d \\ \hline \text{Ans.} & ac+bc+xc+ad+bd+xd \end{array}$$

Here $a+b+x$ is to be added to itself $c+d$ times, i. e. c times and d times.

$$\begin{array}{ll} \text{Ex. 2. Mult.} & a+b-x \\ \text{by} & c-d \\ \hline \text{Ans.} & ac+bc-xc-ad-bd+xd \end{array}$$

Here $a+b$ is to be taken $c-d$ times; that is, c times wanting d times; or c times positively and d times negatively.

$$\begin{array}{ll} \text{Ex. 3. Mult.} & a+b \\ \text{by} & a+b \\ \hline & a^2+ab \\ & \quad\;\; +ab+b^2 \\ \hline \text{Ans.} & a^2+2ab+b^2 \end{array}$$

$$\begin{array}{ll} \text{Ex. 4. Mult.} & x+y \\ \text{by} & x-y \\ \hline & x^2+xy \\ & \quad\;\; -xy-y^2 \\ \hline \text{Ans.} & x^2 \quad * \quad -y^2 \end{array}$$

$$\begin{array}{ll} \text{Ex. 5. Mult.} & 3a^2-5bd \\ \text{by} & -5a^2+4bd \\ \hline & -15a^4+25a^2bd \\ & \qquad\qquad +12a^2bd-20b^2d^2 \\ \hline \text{Ans.} & -15a^4+37a^2bd-20b^2d^2 \end{array}$$

$$\begin{array}{ll} \text{Ex. 6. Mult.} & a^2+2ab+b^2 \\ \text{by} & a^2-2ab+b^2 \\ \hline & a^4+2a^3b+a^2b^2 \\ & \quad\;\; -2a^3b-4a^2b^2-2ab^3 \\ & \qquad\qquad\quad +a^2b^2+2ab^3+b^4 \\ \hline \text{Ans.} & a^4 \quad * \quad -2a^2b^2 \quad * \quad +b^4 \end{array}$$

$$\begin{array}{ll} \text{Ex. 7. Mult.} & 1-x+x^2-x^3 \\ \text{by} & 1+x \\ \hline & 1-x+x^2-x^3 \\ & \quad +x-x^2+x^3-x^4 \\ \hline \text{Ans.} & 1 \quad * \quad * \quad * \quad -x^4 \end{array}$$

$$\begin{array}{ll} \text{Ex. 8. Mult.} & x^2-px+q \\ \text{by} & x+a \\ \hline & x^3-px^2+qx \\ & \quad\;\; +ax^2-apx+aq \\ \hline \text{Ans.} & x^3-\overline{p-a}\,.\,x^2+\overline{q-ap}\,.\,x+aq \end{array}$$

Here the co-efficients of x^2 and x are collected; $-\overline{p-a}\,.\,x^2 = -px^2+ax^2$; and $\overline{q-ap}\,.\,x = qx-apx$.

DIVISION.

To divide one quantity by another, is to determine how often the latter is contained in the former, or what quantity multiplied by the latter will produce the former.

Thus, to divide ab by a is to determine how often a must be taken to make up ab; that is, what quantity multiplied by a will

give $a\,b$; which we know is b. From this consideration are derived all the rules for the division of algebraical quantities.

If the divisor and dividend be affected with *like* signs, the sign of the quotient is $+$: but if their signs be *unlike*, the sign of the quotient is $-$.

If $-a\,b$ be divided by $-a$, the quotient is $+b$; because $-a \times +b$ gives $-a\,b$; and a similar proof may be given in the other cases.

In the division of simple quantities, if the co-efficient and literal product of the divisor be found in the dividend, the other part of the dividend, with the sign determined by the last rule, is the quotient.

Thus, $\frac{a\,b\,c}{a\,b} = c$; because $a\,b$ multiplied by c gives $a\,b\,c$.

If we first divide by a, and then by b, the result will be the same; for $\frac{a\,b\,c}{a} = b\,c$, and $\frac{b\,c}{b} = c$, as before.

Hence, any power of a quantity is divided by any other power of the same quantity, by subtracting the index of the divisor from the index of the dividend.

Thus, $\frac{a^5}{a^3} = a^2$; $\frac{a^5}{a^3} = \frac{1}{a^3} = a^{-3}$; $\frac{a^m}{a^n} = a^{m-n}$.

If only a part of the product which forms the divisor be contained in the dividend, the quantities contained both in the divisor and dividend must be expunged.

Thus, $15\,a^3\,b^2\,c$ divided by $-3\,a^2\,b\,x$, or $\frac{15\,a^3\,b^2\,c}{-3\,a^2\,b\,y} = \frac{-5\,a\,b\,c}{y}$.

First, divide by $-3\,a^2\,b$, and the quotient is $-5\,a\,b\,c$; this quantity is still to be divided by y, and as y is not contained in it, the division can only be represented in the usual way; that is, $\frac{-5\,a\,b\,c}{y}$ is the quotient.

If the dividend consist of several terms, and the divisor be a simple quantity, every term of the dividend must be divided by it.

Thus, $\frac{a^3\,x^2 - 5\,a\,b\,x^3 + 6\,a\,x^4}{a\,x^2} = a^2 - 5\,b\,x + 6\,x^2$.

When the divisor also consists of several terms, arrange both the divisor and dividend according to the powers of some one letter contained in them; then, find how often the first term of the divisor is contained in the first term of the dividend, and write down this quantity for the first term in the quotient; multiply the whole divisor by it, subtract the product from the dividend, and bring down to the remainder as many other terms of the dividend as the case may require, and repeat the operation till all the terms are brought down.

Ex. 1. If $a^2 - 2\,a\,b + b^2$ be divided by $a - b$, the operation will be as follows:

$$\begin{array}{l} a-b)\;a^2 - 2\,a\,b + b^2\;(a-b \\ \qquad\;\; \underline{a^2 - a\,b} \\ \qquad\qquad -a\,b + b^2 \\ \qquad\qquad \underline{-a\,b + b^2} \\ \qquad\qquad\;\; * \quad\; * \end{array}$$

The reason of this, and the foregoing rule, is, that as the whole dividend is made up of all its parts, the divisor is contained in the whole, as often as it is contained in all the parts. In the preceding operation we inquire first, how often a is contained in a^2, which gives a for the first term of the quotient, then multiplying the whole divisor by it, we have $a^2 - a\,b$ to be subtracted from the dividend, and the remainder is $-a\,b + b^2$, with which we are to proceed as before.

The whole quantity $a^2 - 2\,a\,b + b^2$ is in reality divided into two parts by the process, each of which is divided by $a - b$; therefore the true quotient is obtained.

Ex. 2.
$$\begin{array}{l} a+b)\;a\,c + a\,d + b\,c + b\,d\;(c+d \\ \qquad\;\; \underline{a\,c + b\,c} \\ \qquad\qquad a\,d + b\,d \\ \qquad\qquad \underline{a\,d + b\,d} \\ \qquad\qquad\;\; * \quad\; * \end{array}$$

Ex. 3.

$$\begin{array}{l} 1-x)\;1\;\;(1 + x + x^2 + x^3 + \&c. + \frac{\text{Remainder}}{1-x} \\ \qquad\; \underline{1-x} \\ \qquad\; +x \\ \qquad\; \underline{+x - x^2} \\ \qquad\qquad +x^2 \\ \qquad\qquad \underline{+x^2 - x^3} \\ \qquad\qquad\qquad +x^3 \\ \qquad\qquad\qquad \underline{+x^3 - x^4} \\ \qquad\qquad\qquad\quad +x^4 \;\&c. \end{array}$$

Ex. 4.
$$\begin{array}{l} y-1)\;y^3 - 1\;(y^2 + y + 1 \\ \qquad\;\; \underline{y^3 - y^2} \\ \qquad\qquad +y^2 \\ \qquad\qquad \underline{y^2 - y} \\ \qquad\qquad\quad +y - 1 \\ \qquad\qquad\quad \underline{y - 1} \\ \qquad\qquad\qquad * \end{array}$$

Ex. 5.

$$x-a)\,x^3-px^2+qx-r\,(x^2+\overline{a-p}.x+a^2-pa+q$$
$$x^3-ax^2$$
$$\overline{a-p}.x^2+qx$$
$$\overline{a-p}.x^2-\overline{a^2-pa}.x$$
$$+\overline{a^2-pa+q}.x-r$$
$$\overline{a^2-pa+q}.x-a^3-pa^2+qa$$
$$\text{Remainder } a^3-pa^2+qa-r$$

ON THE TRANSFORMATION OF FRACTIONS TO OTHERS OF EQUAL VALUE.

If the signs of all the terms both in the numerator and denominator of a fraction be changed, its value will not be altered. For $\frac{-ab}{-a}=+b=\frac{+ab}{+a}$; and $\frac{ab}{-a}=-b=\frac{-ab}{a}$.

If the numerator and denominator of a fraction be both multiplied, or both divided by the same quantity, its value is not altered. For $\frac{ac}{bc}=\frac{a}{b}$; and $\frac{axyz}{abcz}=\frac{xy}{bc}$.

Hence, a fraction is reduced to its lowest terms, by dividing both the numerator and denominator by the greatest quantity that measures them both.

The greatest common measure of two quantities is found by arranging them according to the powers of some letter, and then dividing the greater by the less, and the preceding divisor always by the last remainder, till the remainder is nothing; the last divisor is the greatest common measure required.

Let a and b be the two quantities, and let b be contained in a, p times, with a remainder c; again, let c be contained in b, q times with a remainder d, and so on, till nothing remains; let d be the last divisor, and it will be the greatest common measure of a and b.

$$b)\,a\,(p$$
$$c)\,b\,(q$$
$$d)\,c\,(r$$
$$0$$

The truth of this rule depends upon these two principles;

1. If one quantity measure another, it will also measure any multiple of that quantity. Let x measure y by the units in n, then it will measure cy by the units in nc.

2. If a quantity measure two others, it will measure their sum or difference. Let a be contained in x, m times, and in y, n times; then $ma=x$ and $na=y$; therefore $x\pm y=ma\pm na=\overline{m\pm n}.a$; i. e. a is contained in $x\pm y$, $m\pm n$ times, or it measures $x\pm y$ by the units in $m\pm n$.

Now it appears from what has been said, that $a-pb=c$, and $b-qc=d$; every quantity therefore which measures a and b, measures pb, and $a-pb$, or c; hence also it measures qc, and $b-qc$, or d; that is, every common measure of a and b measures d.

Ex. To find the greatest common measure of a^4-x^4 and $a^3-a^2x-ax^2+x^3$, and to reduce $\frac{a^4-x^4}{a^3-a^2x-ax^2+x^3}$ to its lowest terms.

$$a^3-a^2x-ax^2+x^3)\,a^4-x^4\,(a+x$$
$$a^4-a^3x-a^2x^2+ax^3$$
$$a^3x+a^2x^2-ax^3-x^4$$
$$a^3x-a^2x^2-ax^3+x^4$$
$$2a^2x^2-2x^4$$

leaving out $2x^2$, which is found in each term of the remainder, the next divisor is a^2-x^2.

$$a^2-x^2)\,a^3-a^2x-ax^2+x^3\,(a-x$$
$$a^3-ax^2$$
$$-a^2x+x^3$$
$$-a^2x+x^3$$
$$*$$

a^2-x^2 is therefore the greatest common measure of the two quantities, and if they be respectively divided by it, the fraction is reduced to $\frac{a^2+x^2}{a-x}$, its lowest terms.

The quantity $2x^2$, found in every term of one of the divisors, $2a^2x^2-2x^4$, but not in every term of the dividend, $a^3-a^2x-ax^2+x^3$, must be left out; otherwise the quotient will be fractional, which is contrary to the supposition made in the proof of the rule; and by omitting this part, $2x^2$, no common measure of the divisor and dividend is left out; because, by the supposition, no part of $2x^2$ is found in all the terms of the dividend.

To find the greatest common measure of three quantities abc; take d the greatest common measure of a and b, and the greatest measure of d and c is the greatest common measure required. In the same manner, the greatest common measure of four or more quantities may be found.

If one number be divided by another, and the preceding divisor by the remainder, according to what has been said, the remainder will at length be less than any quantity that can be assigned.

Fractions are changed to others of equal value with a common denominator, by multiplying each numerator by every denominator except its own, for the new numerator; and all the denominators together for the common denominator.

Let $\frac{a}{b}, \frac{c}{d}, \frac{e}{f}$ be the proposed fractions; then $\frac{adf}{bdf}, \frac{cbf}{bdf}, \frac{edb}{bdf}$, are fractions of the same value with the former, having the common denominator bdf. For $\frac{adf}{bdf}=\frac{a}{b}$; $\frac{cbf}{bdf}=\frac{c}{d}$; and $\frac{edb}{bdf}=\frac{e}{f}$ the numerator and denominator of each fraction having been multiplied by the same quantity, *viz.* the product of the denominators of all the other fractions.

When the denominators of the proposed fractions are not prime to each other, find their greatest common measure; multiply both the numerator and denominator of each fraction, by the denominators of all the rest, divided respectively by their greatest common measure; and the fractions will be reduced to a common denominator in lower terms than they would have been by proceeding according to the former rule.

Thus, $\frac{a}{mx}, \frac{b}{my}, \frac{c}{mz}$; reduced to a common denominator, are $\frac{ayz}{mxyz}$; $\frac{bxz}{mxyz}$; $\frac{cxy}{mxyz}$.

ON THE ADDITION AND SUBTRACTION OF FRACTIONS.

If the fractions to be added have a common denominator, their sum is found by adding the numerators together and retaining the common denominator. Thus,

$$\frac{a}{b}+\frac{c}{b}=\frac{a+c}{b}.$$

If the fractions have not a common denominator they must be transformed to others of the same value, which have a common denominator, and then the addition may take place as before.

Ex. 2. $\frac{a}{b}+\frac{c}{d}=\frac{ad}{bd}+\frac{bc}{bd}=\frac{ad+bc}{bd}$.

Ex. 3. $\frac{1}{a+b}+\frac{1}{a-b}=\frac{a-b}{a^2-b^2}+\frac{a+b}{a^2-b^2}$ $=\frac{a-b+a+b}{a^2-b^2}=\frac{2a}{a^2-b^2}$.

Ex. 4. $a+\frac{c}{f}=\frac{af}{f}+\frac{c}{f}=\frac{af+c}{f}$. Here a is considered as a fraction whose denominator is unity.

If two fractions have a common denominator, their difference is found by taking the difference of the numerators and retaining the common denominator. Thus,

$$\frac{a}{b}-\frac{c}{b}=\frac{a-c}{b}.$$

If they have not a common denominator, they must be transformed to others of the same value, which have a common denominator, and then the subtraction may take place as above.

Ex. 2. $\frac{a}{b}-\frac{c}{d}=\frac{ad}{bd}-\frac{bc}{bd}=\frac{ad-bc}{bd}$.

Ex. 3. $a-\frac{cd}{b}=\frac{ab}{b}-\frac{cd}{b}=\frac{ab-cd}{b}$.

Ex. 4. $\frac{a}{b}-\frac{c+d}{c-d}=\frac{ac-ad}{bc-bd}-\frac{bc+bd}{bc-bd}$ $=\frac{ac-ad-bc-bd}{bc-bd}$.

The sign of bd is negative, because every part of the latter fraction is to be taken from the former.

ON THE MULTIPLICATION AND DIVISION OF FRACTIONS.

To multiply a fraction by any quantity, multiply the numerator by that quantity and retain the denominator.

Thus, $\frac{a}{b}\times c=\frac{ac}{b}$. For if the quantity to be divided be c times as great as before, and the divisor the same, the quotient must be c times as great.

The product of two fractions is found by multiplying the numerators together or a new numerator, and the denominators for a new denominator.

Let $\frac{a}{b}$ and $\frac{c}{d}$ be the two fractions; then $\frac{a}{b}\times\frac{c}{d}=\frac{ac}{bd}$. For if $\frac{a}{b}=x$, and $\frac{c}{d}=y$, by multiplying the equal quantities $\frac{a}{b}$ and x, by b, $a=bx$; in the same manner, $c=dy$; therefore, $ac=bdxy$; dividing these equal quantities, ac and $bdxy$, by bd, we have $\frac{ac}{bd}=xy=\frac{a}{b}\times\frac{c}{d}$.

To divide a fraction by any quantity, multiply the denominator by that quantity, and retain the numerator.

The fraction $\frac{a}{b}$ divided by c, is $\frac{a}{bc}$. Because $\frac{a}{b} = \frac{ac}{bc}$, and a c^{th} part of this is $\frac{a}{bc}$; the quantity to be divided being a c^{th} part of what it was before, and the divisor the same.

The result is the same, whether the denominator is multiplied by the quantity, or the numerator divided by it.

Let the fraction be $\frac{ac}{bd}$; if the denominator be multiplied by c, it becomes $\frac{ac}{bdc}$ or $\frac{a}{bd}$; the quantity which arises from the division of the numerator by c.

To divide one fraction by another, invert the numerator and denominator of the divisor, and proceed as in multiplication.

Let $\frac{a}{b}$ and $\frac{c}{d}$ be the two fractions, then $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$.

For if $\frac{a}{b} = x$, and $\frac{c}{d} = y$, then $a = bx$, and $c = dy$; also, $ad = bdx$, and $bc = bdy$; therefore $\frac{ad}{bc} = \frac{bdx}{bdy} = \frac{x}{y} = \frac{a}{b} \div \frac{c}{d}$.

The rule for multiplying the powers of the same quantity will hold when one or both of the indices are negative.

Thus, $a^m \times a^{-n} = a^{m-n}$; for $a^m \times a^{-n} = a^m \times \frac{1}{a^n} = \frac{a^m}{a^n} = a^{m-n}$; in the same manner, $x^3 \times x^{-5} = \frac{x^3}{x^5} = \frac{1}{x^2} = x^{-2}$.

Again, $a^{-m} \times a^{-n} = a^{\overline{-m+n}}$; because $a^{-m} \times a^{-n} = \frac{1}{a^m} \times \frac{1}{a^n} = \frac{1}{a^{m+n}} = a^{\overline{-m+n}}$

If $m = n$, $a^m \times a^{-m} = a^{m-m} = a^0$; also, $a^m \times a^{-m} = \frac{a^m}{a^m} = 1$; therefore $a^0 = 1$; according to the notation adopted.

The rule for dividing any power of a quantity by any other power of the same quantity holds, whether those powers are positive or negative.

Thus, $a^m \div a^{-n} = a^m \div \frac{1}{a^n} = a^m \times a^n = a^{m+n}$.

Again, $a^{-m} \div a^{-n} = \frac{1}{a^m} \div \frac{1}{a^n} = \frac{a^n}{a^m} = a^{n-m}$.

Hence it appears, that a quantity may be transferred from the numerator of a fraction to the denominator, and the contrary, by changing the sign of its index. Thus,

$\frac{a^m \times a^n}{b^p} = \frac{a^m}{b^p a^{-n}}$; and $\frac{a^m}{a^n b^p} = \frac{a^m \times a^{-n}}{b^p}$.

ON INVOLUTION AND EVOLUTION.

INVOLUTION. If a quantity be continually multiplied by itself, it is said to be involved, or raised; and the power to which it is raised is expressed by the number of times the quantity has been employed in the multiplication.

Thus, $a \times a$, or a^2, is called the second power of a; $a \times a \times a$, or a^3, the third power; $a \times a \ldots . (n)$, or a^n, the n^{th} power.

If the quantity to be involved be negative, the signs of the even powers will be positive, and the signs of the odd power negative.

For $-a \times -a = a^2$; $-a \times -a \times -a = -a^3$, &c.

A simple quantity is raised to any power, by multiplying the index of every factor in the quantity by the exponent of the power, and prefixing the proper sign determined by the last article.

Thus, a^m raised to the n^{th} power is a^{mn}. Because $a^m \times a^m \times a^m \ldots$ to n factors, by the rule of multiplication, is a^{mn}; also, $\overline{ab}|^n = ab \times ab \times ab \times$ &c. to n factors, or $a \times a \times a \ldots .$ to n factors $\times b \times b \times b \ldots .$ to n factors $= a^n \times b^n$; and $a^2 b^3 c$ raised to the fifth power is $a^{10} b^{15} c^5$. Also, $-a^m$ raised to the n^{th} power is $\pm a^{mn}$; where the positive or negative sign is to be prefixed, according as n is an even or odd number.

If the quantity to be involved be a fraction, both the numerator and denominator must be raised to the proposed power.

If the quantity proposed be a compound one, the involution may either be represented by the proper index, or it may actually take place.

Let $a + b$ be the quantity to be raised to any power.

$$
\begin{array}{rl}
 & a + b \\
 & a + b \\
\hline
 & a^2 + ab \\
 & \quad + ab + b^2 \\
\hline
\overline{a \times b}|^2 \text{ or} & a^2 + 2ab + b^2 \text{ the sq. or 2}^{\text{d}} \text{ power} \\
 & a + b \\
\hline
 & a^3 + 2a^2 b + a b^2 \\
 & \quad + a^2 b + 2ab^2 + b^3 \\
\hline
\overline{a + b}|^3 \text{ or} & a^3 + 3a^2 b + 3ab^2 + b^3 \text{ the 3}^{\text{d}} \text{ p.} \\
 & a + b \\
\hline
 & a^4 + 3a^3 b + 3a^2 b^2 + ab^3 \\
 & \quad + a^3 b + 3a^2 b^2 + 3ab^3 + b^4 \\
\hline
\overline{a + b}|^4 \text{ or} & a^4 + 4a^3 b + 6a^2 b^2 + 4ab^3 + b^4 \\
\hline
\end{array}
$$

the fourth power.

If b be negative, or the quantity to be involved be $a - b$, wherever an odd power of b enters, the sign of the term must be negative.

Hence, $\overline{a-b}|^4 = a^4 - 4a^3b + 6a^2b^2 - 4ab^3 + b^4$.

Evolution, or the extraction of roots, is the method of determining a quantity which raised to a proposed power will produce a given quantity.

Since the n^{th} power of a^m is a^{mn}, the n^{th} root of a^{mn} must be a^m; *i. e.* to extract any root of a single quantity, we must divide the index of that quantity by the index of the root required.

When the index of the quantity is not exactly divisible by the number which expresses the root to be extracted, that root must be represented according to the notation already pointed out.

Thus, the square, cube, fourth, n^{th} root of $a^2 + x^2$, are respectively represented by $\overline{a^2+x^2}|^{\frac{1}{2}}$, $\overline{a^2+x^2}|^{\frac{1}{3}}$, $\overline{a^2+x^2}|^{\frac{1}{4}}$, $\overline{a^2+x^2}|^{\frac{1}{n}}$; the same roots of $\frac{1}{a^2+x^2}$, or $\overline{a^2+x^2}|^{-1}$, are represented by $\overline{a^2+x^2}|^{-\frac{1}{2}}$, $\overline{a^2+x^2}|^{-\frac{1}{3}}$, $\overline{a^2+x^2}|^{-\frac{1}{4}}$, $\overline{a^2+x^2}|^{-\frac{1}{n}}$.

If the root to be extracted be expressed by an odd number, the sign of the root will be the same with the sign of the proposed quantity.

If the root to be extracted be expressed by an even number, and the quantity proposed be positive, the root may be either positive or negative. Because either a positive or negative quantity, raised to such a power, is positive.

If the root proposed to be extracted be expressed by an even number, and the sign of the proposed quantity be negative, the root cannot be extracted; because no quantity, raised to an even power, can produce a negative result. Such roots are called impossible.

Any root of a product may be found by taking that root of each factor, and multiplying the roots, so taken, together.

Thus, $\overline{ab}|^{\frac{1}{n}} = a^{\frac{1}{n}} \times b^{\frac{1}{n}}$; because each of these quantities, raised to the n^{th} power, is ab.

In $a = b$, then $a^{\frac{1}{n}} \times a^{\frac{1}{n}} = a^{\frac{2}{n}}$; and in the same manner, $a^{\frac{r}{n}} \times a^{\frac{s}{n}} = a^{\frac{r+s}{n}}$.

Any root of a fraction may be found by taking that root both of the numerator and denominator. Thus, the cube root of $\frac{a^2}{b^2}$ is $\frac{a^{\frac{2}{3}}}{b^{\frac{2}{3}}}$, or $a^{\frac{2}{3}} \times b^{-\frac{2}{3}}$; and $\overline{\frac{a}{b}}|^{\frac{1}{n}} = \frac{a^{\frac{1}{n}}}{b^{\frac{1}{n}}}$, or $a^{\frac{1}{n}} \times b^{-\frac{1}{n}}$.

To extract the square root of a compound *quantity.*

$$
\begin{array}{rl}
 & a^2 + 2ab + b^2 \,(a + b \\
 & a^2 \\
\hline
2a + b) & 2ab + b^2 \\
 & 2ab + b^2 \\
\hline
 & * \quad *
\end{array}
$$

Since the square root of $a^2 + 2ab + b^2$ is $a + b$ whatever be the values of a and b, we may obtain a general rule for the extraction of the square root, by observing in what manner a and b may be derived from $a^2 + 2ab + b^2$.

Having arranged the terms according to the dimensions of one letter, a, the square root of the first term, a^2, is a, the first factor in the root; subtract its square from the whole quantity, and bring down the remainder $2ab + b^2$; divide $2ab$ by $2a$, and the result is b, the other factor in the root; then multiply the sum of twice the first factor and the second $(2a + b)$, by the second (b), and subtract this product $(2ab + b^2)$ from the remainder. If there be no more terms, consider $a + b$ as a new value of a; and its square, that is $a^2 + 2ab + b^2$, having, by the first part of the process, been subtracted from the proposed quantity, divide the remainder by the double of this new value of a, for a new factor in the root; and for a new subtrahend, multiply this factor by twice the sum of the former factors increased by this factor. The process must be repeated till the root, or the necessary approximation to the root, is obtained.

Ex. 1. To extract the square root of $a^2 + 2ab + b^2 + 2ac + 2bc + c^2$.

$$
\begin{array}{rl}
 & a^2 + 2ab + b^2 + 2ac + 2bc + c^2 \,(a + b + c \\
 & a^2 \\
\hline
2a + b) & 2ab + b^2 \\
 & 2ab + b^2 \\
\hline
2a + 2b + c) & * \quad * \quad 2ac + 2bc + c^2 \\
 & \qquad\quad\;\; 2ac + 2bc + c^2 \\
\hline
 & \qquad\quad\;\; * \quad * \quad *
\end{array}
$$

Ex. 2. To extract the square root of $a^2 - ax + \frac{x^2}{4}$

$$
\begin{array}{rl}
 & a^2 - ax + \frac{x^2}{4} \left(a - \frac{x}{2}\right. \\
 & a^2 \\
\hline
2a - \frac{x}{2}) & - ax + \frac{x^2}{4} \\
 & - ax + \frac{x^2}{4} \\
\hline
 & \quad * \quad *
\end{array}
$$

Ex. 3. To extract the square root of $1+x$.

$$1+x\ \left(1+\frac{x}{2}-\frac{x^2}{8}\ \&c.\right.$$

$$\begin{array}{rl}
 & 1 \\
\hline
2+\frac{x}{2}) & x \\
 & x+\frac{x^2}{4} \\
\hline
2+x-\frac{x^2}{8}) & -\frac{x^2}{4} \\
 & -\frac{x^2}{4}-\frac{x^3}{8}+\frac{x^4}{64} \\
\hline
 & \frac{x^3}{8}-\frac{x^4}{64}\ \&c. \\
\hline
\end{array}$$

It appears from the second example, that a trimonial $a^2-ax+\frac{x^2}{4}$, in which four times the product of the first and last terms is equal to the square of the middle term, is a complete square, or $a^2\times\frac{x^2}{4}\times 4=a^2x^2$.

The method of extracting the cube root is discovered in the same manner.

$$\begin{array}{rl}
 & a^3+3a^2b+3ab^2+b^3\ (a+b \\
 & a^3 \\
\hline
3a^2) & 3a^2b+3ab^2+b^3 \\
 & 3a^2b+3ab^2+b^3 \\
\hline
 & * \\
\end{array}$$

The cube root of $a^3+3a^2b+3ab^2+b^3$ is $a+b$; and to obtain $a+b$ from this compound quantity, arrange the terms as before, and the cube root of the first term, a^3, is a, the first factor in the root; subtract its cube from the whole quantity, and divide the first term of the remainder by $3a^2$, the result is b, the second factor in the root; then subtract $3a^2b+3ab^2+b^3$ from the remainder, and the whole cube of $a+b$ has been subtracted. If any quantity be left, proceed with $a+b$ as a new a, and divide the last remainder by $3.\overline{a+b}|^2$ for a third factor in the root; and thus any number of factors may be obtained.

ON SIMPLE EQUATIONS.

If one quantity be equal to another, or to nothing, and this equality be expressed algebraically, it constitutes an *equation*. Thus, $x-a=b-x$ is an equation, of which $x-a$ forms one side, and $b-x$ the other.

When an equation is cleared of fractions and surds, if it contain the first power only of an unknown quantity, it is called a *simple equation*, or an equation of one dimension: if the *square* of the unknown quantity be in any term, it is called a *quadratic*, or an equation of two dimensions; and in general, if the index of the highest power of the unknown quantity be n, it is called *an equation of n dimensions.*

In any equation, quantities may be transposed from one side to the other, if their signs be changed, and the two sides will still be equal.

Let $x+10=15$, then by subtracting 10 from each side, $x+10-10=15-10$, or $x=15-10$.

Let $x-4=6$, by adding 4 to each side, $x-4+4=6+4$, or $x=6+4$.

If $x-a+b=y$; adding $a-b$ to each side, $x-a+b+a-b=y+a-b$; or $x=y+a-b$.

Hence, if the signs of *all* the terms on each side be changed, the two sides will still be equal.

Let $x-a=b-2x$; by transposition, $-b+2x=-x+a$; or $a-x=2x-b$.

If every term, on each side, be multiplied by the same quantity, the results will be equal.

An equation may be cleared of fractions, by multiplying every term, successively, by the denominators of those fractions, excepting those terms in which the denominators are found.

Let $3x+\frac{5x}{4}=34$; multiplying by 4, $12x+5x=136$, or $17x=136$.

If each side of an equation be divided by the same quantity, the results will be equal.

Let $17x=136$; then $x=\frac{136}{17}=8$.

If each side of an equation be raised to the same power, the results will be equal.

Let $x^{\frac{1}{2}}=9$; then $x=9\times 9=81$.

Also, if the same root be extracted on both sides, the results will be equal.

Let $x=81$; then $x^{\frac{1}{2}}=9$.

To find the value of an unknown quantity in a simple equation.

Let the equation first be cleared of fractions, then transpose all the terms which involve the unknown quantity to one side of the equation, and the known quantities to the other; divide both sides by the co-efficient, or sum of the co-efficients, of the unknown quantity, and the value required is obtained.

Ex. 1. To find the value of x in the equation $3x-5=23-x$.

$$\begin{array}{rl}
\text{by transp.} & 3x+x=23+5 \\
\text{or} & 4x=28 \\
\text{by division} & x=\frac{28}{4}=7.
\end{array}$$

Ex. 2. Let $x + \frac{x}{2} - \frac{x}{3} = 4x - 17$.

Mult. by 2, and $2x + x - \frac{2x}{3} = 8x - 34$

Mult. by 3, and $6x + 3x - 2x = 24x - 102$

by transp. $6x + 3x - 2x - 24x = -102$

or $-17x = -102$

$17x = 102$

$$x = \frac{102}{17} = 6.$$

Ex. 3. $\frac{1}{a} + \frac{b}{x} = c$.

$$1 + \frac{ba}{x} = ca$$

$x + ba = cax$

$x - cax = -bd$

or $cax - x = ba$

i.e. $\overline{ca - 1}\,.\,x = ba$

$$x = \frac{ba}{ca - 1}.$$

Ex. 4. $5 - \frac{x+4}{11} = x - 3$.

$55 - x - 4 = 11x - 33$.

$55 - 4 + 33 = 11x + x$

$84 = 12x$

$$x = \frac{84}{12} = 7.$$

Ex. 5. $x + \frac{3x - 5}{2} = 12 - \frac{2x - 4}{3}$.

$$2x + 3x - 5 = 24 - \frac{4x - 8}{3}$$

$6x + 9x - 15 = 72 - 4x + 8$

$6x + 9x + 4x = 72 + 8 + 15$

$19x = 95$

$$x = \frac{95}{19} = 5.$$

If there be two independent simple equations involving two unknown quantities, they may be reduced to one which involves only one of the unknown quantities, by any of the following methods:

1st Method. In either equation, find the value of one of the unknown quantities in terms of the other and known quantities, and for it substitute this value in the other equation, which will then only contain one unknown quantity, whose value may be found by the rules before laid down.

Let $\left\{\begin{array}{l} x + y = 10 \\ 2x - 3y = 5 \end{array}\right\}$ To find x and y.

From the first equat. $x = 10 - y$; hence, $2x = 20 - 2y$,

by subst. $20 - 2y - 3y = 5$

$20 - 5 = 2y + 3y$

$15 = 5y$

$$y = \frac{15}{5} = 3$$

hence also, $x = 10 - y = 10 - 3 = 7$.

2d Method. Find an expression for one of the unknown quantities, in each equation; put these expressions equal to each other, and from the resulting equation the other unknown quantity may be found.

Let $\left\{\begin{array}{l} x + y = a \\ bx + cy = de \end{array}\right\}$ To find x and y.

From the first equat. $x = a - y$

from the second, $bx = de - cy$, and $x = \frac{de - cy}{b}$

therefore $a - y = \frac{de - cy}{b}$

$ba - by = de - cy$

$cy - by = de - ba$

$\overline{c - b}\,.\,y = de - ba$

$$y = \frac{de - bn}{c - b}.$$

Also, $x = a - y$; that is,

$$x = a - \frac{de - ba}{c - b} = \frac{ca - ba - de + ba}{c - b}$$

$$= \frac{ca - de}{c - b}.$$

3d Method. If either of the unknown quantities have the same co-efficient in both equations, it may be exterminated by subtracting, or adding, the equations, according as the sign of the unknown quantity, in the two cases, is the same or different.

Let $\left\{\begin{array}{l} x + y = 15 \\ x - y = 7 \end{array}\right\}$ To find x and y.

By subtraction, $2y = 8$, and $y = 4$

By addition, $2x = 22$, and $x = 11$.

If the co-efficients of the unknown quantity to be exterminated be different, multiply the terms of the first equation by the co-efficient of the unknown quantity in the second, and the terms of the second equation by the co-efficient of the same unknown quantity in the first; then add, or subtract, the resulting equations, as in the former case.

Ex. 1. Let $\left\{\begin{array}{l} 3x - 5y = 13 \\ 2x + 7y = 81 \end{array}\right\}$ To find x and y.

Multiply the terms of the first equation by 2, and the terms of the other by 3,

then $6x - 10y = 26$

$6x + 21y = 243$

By subtraction, $-31y = -217$

and $y = \frac{217}{31} = 7$;

also, $3x - 5y = 13$, or $3x - 35 = 13$

therefore, $3x = 13 + 35 = 48$

and $x = \frac{48}{3} = 16$.

Ex. 2. Let $\left\{\begin{array}{l} ax+by=c \\ mx-ny=d \end{array}\right\}$ To find x and y.

From the first, $max+mby=mc$
from the other, $max-nay=ad$
by subtraction, $mby+nay=mc-ad$

therefore, $y=\dfrac{mc-ad}{mb+na}$.

Again, $nax+nby=nc$
$mbx-nby=bd$
by addition, $\overline{na+mb}\,.\,x=nc+bd$

therefore, $x=\dfrac{nc+bd}{na+mb}$.

If there be three independent simple equations, and three unknown quantities, reduce two of the equations to one, containing only two of the unknown quantities, by the preceding rules; then reduce the third equation and either of the former to one, containing the same two unknown quantities; and from the two equations thus obtained, the unknown quantities which they involve may be found. The third quantity may be found by substituting their values in any of the proposed equations.

Ex. Let $\left\{\begin{array}{l} 2x+3y+4z=16 \\ 3x+2y-5z=8 \\ 5x-6y+3z=6 \end{array}\right\}$ To find x, y, and z.

From the 2 first equat. $6x+9y+12z=48$
$6x+4y-10z=16$
by subtr. $5y+22z=32$
from the 1st and 3rd, $10x+15y+20z=80$
$10x-12y+6z=12$
by subtr. $27y+14z=68$
and $5y+22z=32$
hence $135y+70z=340$
and $135y+594z=864$
by subtr. $524z=524$
$z=1$
$5y+22z=32$
that is, $5y+22=32$
$5y=32-22=10$
$y=\dfrac{10}{5}=2$
$2x+3y+4z=16$
that is, $2x+6+4=16$
$2x=16-6-4=6$
$x=3$.

The same method may be applied to any number of simple equations.

That the unknown quantities may have definite values, there must be as many independent equations as unknown quantities.

Thus, if $x+y=a$, $x=a-y$; and assuming y at pleasure, we obtain a value of x, such, that $x+y=a$.

These equations must also be independent, that is, not deducible one from another.

Let $x+y=a$, and $2x+2y=2a$; this latter equation being deducible from the former, it involves no different supposition, nor requires any thing more for its truth, than that $x+y=a$ should be a just equation.

PROBLEMS WHICH PRODUCE SIMPLE EQUATIONS.

From certain quantities which are known, to investigate others which have a given relation to them, is the business of Algebra.

When a question is proposed to be resolved, we must first consider fully its meaning and conditions. Then substituting for such unknown quantities as appear most convenient, we must proceed as if they were already determined, and we wished to try whether they would answer all the proposed conditions or not, till as many independent equations arise as we have assumed unknown quantities, which will always be the case if the question be properly limited; and by the solution of these equations, the quantities sought will be determined.

Prob. 1. To divide a line of 15 inches into two such parts, that one may be three-fourths of the other.

Let $4x=$ one part,
then $3x=$ the other.
$7x=15$, by the question,
$x=\dfrac{15}{7}$
$4x=\dfrac{60}{7}=8\dfrac{4}{7}$, one part,
$3x=\dfrac{45}{7}=6\dfrac{3}{7}$, the other.

Prob. 2. If A can perform a piece of work in 8 days, and B in 10 days, in what time will they finish it together?

Let x be the time required.

In one day, A performs $\frac{1}{8}$ part of the work; therefore in x days, he performs $\frac{x}{8}$ parts of it; and in the same time, B performs $\frac{x}{10}$ parts of it; and calling the work 1,

$\dfrac{x}{8}+\dfrac{x}{10}=1$.
$10x+8x=80$
$18x=80$
$x=\dfrac{80}{18}=4\dfrac{8}{18}=4\dfrac{4}{9}$ days.

Prob. 3. A and B play at bowls, and A bets B three shillings to two upon every game; after a certain number of games it

appears, that A has won three shillings; but had he ventured to bet five shillings to two, and lost one game more out of the same number, he would have lost thirty shillings: how many games did they play?

Let x { be the number of games A won,
y the number of B won,
then $2x$ is what A won of B,
and $3y$ what B won of A.

$2x - 3y = 3$, by the question;

$\overline{x-1}.2$, { A would win on the 2^d^ supposition,

$\overline{y+1}.5$, B would win,

$5y + 5 - 2x + 2 = 30$, by the question.

or $5y - 2x = 30 - 5 - 2 = 23$

therefore, $5y - 2x = 23$

and $2x - 3y = 3$

by addition, $5y - 3y = 26$

$2y = 26$

$y = 13$

$2x = 3 + 3y = 3 + 39 = 42$

$x = 21$

$x + y = 34$, the num. of games.

ON QUADRATIC EQUATIONS.

When the terms of an equation involve the square of an unknown quantity, but the first power does not appear, the value of the square is obtained by the preceding rules; and by extracting the square root on both sides, the quantity itself is found.

Ex. 1. Let $5x^2 - 45 = 0$; to find x.

By trans. $5x^2 = 45$

$x^2 = 9$

therefore, $x = \sqrt{9} = \pm 3$.

The signs $+$ and $-$ are both prefixed to the root, because the square root of a quantity may be either positive or negative. The sign of x may also be negative; but still x will be either equal to $+3$ or -3.

Ex. 2. Let $ax^2 = bcd$; to find x.

$$x^2 = \frac{bcd}{a}$$

$$x = \pm \sqrt{\frac{bcd}{a}}.$$

If both the first and second powers of the unknown quantity be found in an equation: Arrange the terms according to the dimensions of the unknown quantity, beginning with the highest, and transpose the known quantities to the other side; then, if the square of the unknown quantity be affected with a co-efficient, divide all the terms by this co-efficient, and if its sign be negative, change the signs of all the terms, that the equation may be reduced to this form, $x^2 \pm px = \pm q$. Then add to both sides the square of half the co-efficient of the first power of the unkwown quantity, by which means the first side of the equation is made a complete square, and the other consists of known quantities; and by extracting the square root on both sides, a simple equation is obtained, from which the value of the unkwown quantity may be found.

Ex. 1. Let $x^2 + px = q$; now, we know that $x^2 + px + \frac{p^2}{4}$ is the square of $x + \frac{p}{2}$, add therefore, $\frac{p^2}{4}$ to both sides, and we have

$x^2 + px + \frac{p^2}{4} = q + \frac{p^2}{4}$; then by extracting the square root on both sides,

$x + \frac{p}{2} = \pm \sqrt{q + \frac{p^2}{4}}$, and by transp.

$$x = -\frac{p}{2} \pm \sqrt{q + \frac{p^2}{4}}.$$

In the same manner, if $x^2 - px = q$, x is found to be $\frac{p}{2} \pm \sqrt{q + \frac{p^2}{4}}$.

Ex. 2. Let $x^2 - 12x + 35 = 0$; to find x. By transposition, $x^2 - 12x = -35$, and adding the square of 6 to both sides of the equation,

$x^2 - 12x + 36 = 36 - 35 = 1$;

then extracting the square root on both sides,

$x - 6 = \pm 1$

$x = 6 \pm 1 = 7$ or 5; either of which, substituted for x in the original equation, answers the condition, that is, makes the whole equal to nothing.

Ex. 3. Let $x + \sqrt{5x + 10} = 8$; to find x.

By transposition, $\sqrt{5x + 10} = 8 - x$

squar. both sides, $5x + 10 = 64 - 16x + x^2$

$x^2 - 21x = 10 - 64 = -54$

compl. the sq. $x^2 - 21x + \frac{441}{4} = \frac{441}{4} - 54$

$= \frac{441 - 216}{4}$, or $x^2 - 21x + \frac{441}{4} = \frac{225}{4}$

extracting the square root, $x - \frac{21}{2} = \pm \frac{15}{2}$

$$x = \frac{21 \pm 15}{2} = 3 \text{ or } 18.$$

By this process two values of x are found, but on trial it appears, that 18 does not answer the condition of the equation, if we suppose that $\sqrt{5x + 10}$ represents the posi-

tive square root of $5x+10$. The reason is, that $5x+10$ is the square of $-\sqrt{5x+10}$ as well as of $+\sqrt{5x+10}$; thus by squaring both sides of the equation $\sqrt{5x+10} = 8-x$, a new condition is introduced, and a new value of the unknown quantity corresponding to it, which had no place before. Here, 18 is the value which corresponds to the supposition that $x-\sqrt{5x+10}=8$.

Every equation, where the unknown quantity is found in two terms, and its index in one is twice as great as in the other, may be resolved in the same manner.

Ex. 4. Let $z+4z^{\frac{1}{2}}=21$

$$z+4z^{\frac{1}{2}}+4=21+4=25$$
$$z^{\frac{1}{2}}+2=\pm 5$$
$$z^{\frac{1}{2}}=\pm 5-2=3, \text{ or } -7.$$

therefore $z=9$, or 49.

Ex. 5. Let $y^4-6y^2-27=0$.

$$y^4-6y^2=27$$
$$y^4-6y^2+9=27+9=36$$
$$y^2-3=\pm 6$$
$$y^2=3\pm 6=9, \text{ or } -3$$
$$y=\pm 3, \text{ or } \pm\sqrt{-3}.$$

Ex. 6. Let $y^6+ry^3+\frac{q^3}{27}=0$.

$$y^6+ry^3=-\frac{q^3}{27}$$
$$y^6+ry^3+\frac{r^2}{4}=\frac{r^2}{4}-\frac{q^3}{27}$$
$$y^3+\frac{r}{2}=\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}.$$
$$y^3=-\frac{r}{2}\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}.$$
$$y=\sqrt[3]{-\frac{r}{2}\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}.$$

When there are more equations and unknown quantities than one, a single equation, involving only one of the unknown quantities, may sometimes be obtained by the rules laid down for the solution of simple equations; and one of the unknown quantities being discovered, the others may be obtained by substituting its value in the preceding equations.

Ex 7. Let $\left\{\begin{matrix} x^2+y^2=65 \\ xy=28 \end{matrix}\right\}$ To find x and y.

From the second equation, $2xy=56$

and adding this to the first, $x^2+2xy+y^2=121$

subtract it from the same, $x^2-2xy+y^2=9$

by extracting the sq. roots, $x+y=\pm 11$

$$\text{and } x-y=\pm 3$$
$$\text{therefore, } 2x=\pm 14$$
$$x=7, \text{ or } -7$$
$$\text{and } y=4, \text{ or } -4.$$

PROBLEMS PRODUCING QUADRATIC EQUATIONS.

Prob. 1. To divide a line of 20 inches into two such parts, that the rectangle under the whole and one part, may be equal to the square of the other.

Let x be the greater part, then will $20-x$ be the less,

and $x^2=\overline{20-x}\,.\,20=400-20x$ by the question.

$$x^2+20x=400$$
$$x^2+20x+100=400+100=500$$
$$x+10=\pm\sqrt{500}$$
$$x=+\sqrt{500}-10, \text{ or } -\sqrt{500}-10.$$

Prob. 2. To find two numbers, whose sum, product, and the sum of whose squares, are equal to each other.

Let $x+y$ and $x-y$ be the numbers;

their sum is $2x$

their product x^2-y^2

the sum of their sqs. $2x^2+2y^2$

and by the question $2x=2x^2+2y^2$

$$\text{or } x=x^2+y^2$$
$$\text{also, } 2x=x^2-y^2$$
$$\text{therefore, } 3x=2x^2$$
$$x=\frac{3}{2}$$
$$2x=x^2-y^2$$
$$\text{or } 3=\frac{9}{4}-y^2$$
$$y^2=\frac{9}{4}-3=\frac{9-12}{4}=\frac{-3}{4}$$
$$y=\pm\frac{\sqrt{-3}}{2}$$
$$x+y=\frac{3+\sqrt{-3}}{2}$$
$$x-y=\frac{3-\sqrt{-3}}{2}.$$

Since the square of every quantity is positive, a negative quantity has no square root; the conclusion therefore shews that there are no such numbers as the question supposes. See Binomial Theorem; Equations, *nature of*; Series, Surds, &c. &c.

Algebra, *application of to geometry*.—The first and principal applications of algebra were to arithmetical questions and computations, as being the first and most useful science in all the concerns of human

life. Afterwards algebra was applied to geometry, and all the other sciences in their turn. The application of algebra to geometry, is of two kinds; that which regards the plane or common geometry, and that which respects the higher geometry, or the nature of curve lines.

The first of these, or the application of algebra to common geometry, is concerned in the algebraical solution of geometrical problems, and finding out theorems in geometrical figures, by means of algebraical investigations or demonstrations. This kind of application has been made from the time of the most early writers on algebra, as Diophantus, Cardan, &c. &c. down to the present times. Some of the best precepts and exercises of this kind of application are to be met with in Sir I. Newton's "Universal Arithmetic," and in Thomas Simpson's "Algebra and Select Exercises." Geometrical Problems are commonly resolved more directly and easily by algebra, than by the geometrical analysis, especially by young beginners; but then the synthesis, or construction and demonstration, is most elegant as deduced from the latter method. Now it commonly happens that the algebraical solution succeeds best in such problems as respect the sides and other lines in geometrical figures; and, on the contrary, those problems in which angles are concerned, are best effected by the geometrical analysis. Sir Isaac Newton gives these, among many other remarks on this branch. Having any problem proposed, compare together the quantities concerned in it; and, making no difference between the known and unknown quantities, consider how they depend, or are related to, one another; that we may perceive what quantities, if they are assumed, will, by proceeding synthetically, give the rest, and that in the simplest manner. And in this comparison, the geometrical figure is to be feigned and constructed at random, as if all the parts were actually known or given, and any other lines drawn that may appear to conduce to the easier and simpler solution of the problem. Having considered the method of computation, and drawn out the scheme, names are then to be given to the quantities entering into the computation, that is, to some few of them, both known and unknown, from which the rest may most naturally and simply be derived or expressed, by means of the geometrical properties of figures, till an equation be obtained, by which the value of the unknown quantity may be derived by the ordinary methods of reduction of equations, when only one unknown quantity is in the notation; or till as many equations are obtained as there are unknown letters in the notation.

For example: suppose it were required to inscribe a square in a given triangle. Let ABC, (Plate Miscellanies, fig. 1.) be the given triangle; and feign DEFG to be the required square; also draw the perpendicular BP of the triangle, which will be given, as well as all the sides of it. Then, considering that the triangles BAC, BEF are similar, it will be proper to make the notation as follows, viz. making the base $AC = b$, the perpendicular $BP = p$, and the side of the square DE or $EF = x$. Hence then $BQ = BP - ED = p - x$; consequently, by the proportionality of the parts of those two similar triangles, viz. $BP : AC :: BQ : EF$, it is $p : b :: p - x : x$; then, multiply extremes and means, &c. there arises $px = bp - bx$, or $bx + px = bp$, and $x = \frac{bp}{b+p}$, the side of the square sought; that is, a fourth proportional to the base and perpendicular, and the sum of the two, taking this sum for the first term, or $AC + BP : BP :: AC : EF$.

The other branch of the application of algebra to geometry, was introduced by Descartes, in his Geometry, which is the new or higher geometry, and respects the nature and properties of curve lines. In this branch, the nature of the curve is expressed or denoted by an algebraic equation, which is thus derived: A line is conceived to be drawn, as the diameter or some other principal line about the curve; and upon any indefinite points of this line other lines are erected perpendicularly, which are called ordinates, whilst the parts of the first line cut off by them are called abscisses. Then, calling any absciss x, and its corresponding ordinate y, by means of the known nature, or relations, of the other lines in the curve, an equation is derived, involving x and y, with other given quantities in it. Hence, as x and y are common to every point in the primary line, that equation, so derived, will belong to every position or value of the absciss and ordinate, and so is properly considered as expressing the nature of the curve in all points of it; and is commonly called the equation of the curve.

In this way it is found that any curve line has a peculiar form of equation belonging to it, and which is different from that of

every other curve, either as to the number of the terms, the powers of the unknown letters x and y, or the signs or co-efficients of the terms of the equation. Thus, if the curve line HK, (fig. 2.) be a circle, of which HI is part of the diameter, and IK a perpendicular ordinate: then put HI $= x$, IK $= y$, and $p =$ the diameter of the circle, the equation of the circle will be $px - x^2 = y^2$. But if HK be an ellipse, an hyperbola, or parabola, the equation of the curve will be different, and for all the four curves, will be respectively as follows: viz.

For the circle............$px - x^2 = y^2$,

For the ellipse ....$px - \frac{p}{t} x^2 = y^2$,

For the hyperbola ......$px + \frac{p}{t} x^2 = y^2$,

For the parabola ..... px - - $= y^2$;

where t is the transverse axis, and p its parameter. And in like manner for other curves.

This way of expressing the nature of curve lines, by algebraic equations, has given occasion to the greatest improvement and extension of the geometry of curve lines; for thus, all the properties of algebraic equations, and their roots, are transferred and added to the curve lines, whose abscisses and ordinates have similar properties. Indeed the benefit of this sort of application is mutual and reciprocal, the known properties of equations being transferred to the curves they represent; and, on the contrary, the known properties of curves transferred to their representative equations.

Besides the use and application of the higher geometry, namely of curve lines, to detecting the nature and roots of equations, and to the finding the values of those roots by the geometrical construction of curve lines, even common geometry may be made subservient to the purposes of algebra. Thus, to take a very plain and simple instance, if it were required to square the binomial $a + b$; (fig. 3.) by forming a square, as in the figure, whose side is equal to $a + b$, or the two lines or parts added together denoted by the letters a and b; and then drawing two lines parallel to the sides, from the points where the two parts join, it will be immediately evident that the whole square of the compound quantity $a + b$ is equal to the squares of both the parts, together with two rectangles under the two parts, or a^2 and b^2 and $2ab$, that is, the square of $a + b$ is equal to $a^2 + b^2 + 2ab$, as derived from a geometrical figure or construction. And in this very manner it was, that the Arabians, and the early European writers on algebra, derived and demonstrated the common rule for resolving compound quadratic equations. And thus also, in a similar way, it was, that Tartalea and Cardan derived and demonstrated all the rules for the resolution of cubic equations, using cubes and parallelopipedons instead of squares and rectangles. Many other instances might be given of the use and application of geometry in algebra.

ALGOL, the name of a fixed star of the third magnitude in the constellation Perseus, otherwise called *Medusa's head.* This star has been subject to singular variations, appearing at different times of different magnitudes, from the fourth to the second, which is its usual appearance. These variations have been noticed with great accuracy and the period of their return is determined to be $2^d\ 20^h\ 48'\ 56''$. The cause of this variation, Mr. Goodricke, who has attended closely to the subject, conjectures, may be either owing to the interposition of a large body revolving round Algol, or to some motion of its own, in consequence of which, part of its body, covered with spots or some such like matter, is periodically turned towards the earth.

ALGORITHM, an Arabic term, not unfrequently used to denote the practical rules of algebra, and sometimes for the practice of common arithmetic; in which last sense it coincides with *logistica numeralis*, or the art of numbering truly and readily.

ALIEN, in law, a person born in a strange country, not within the king's allegiance, in contradistinction from a denizen or natural subject.

An alien is incapable of inheriting lands in England, till naturalized by an act of parliament. No alien is entitled to vote in the choice of members of parliament, has a right to enjoy offices, or can be returned on any jury, unless where an alien is party in a cause; and then the inquest of jurors shall be one half denizens and the other aliens.

Every alien neglecting the king's proclamation directing him to depart from the realm within a limited time, shall, on conviction, for the first offence be imprisoned for any time not exceeding one month, and

not exceeding twelve months for the second; at the expiration of which, he shall depart within a time to be limited: and if such alien be found therein after such time so limited, he or she shall be transported for life.

ALIMENTARY *duct*, a name by which some call the intestines, on account of the food's passing through them. See ANATOMY.

ALIMONY, *alimonia*, in law, denotes the maintenance sued for by a wife, in case of a separation from her husband, wherein she is neither chargeable with elopement nor adultery.

ALIQUANT *parts*, in arithmetic, those which will not divide or measure the whole number exactly. Thus, 7 is an aliquant part of 16, for twice 7 wants 2 of 16, and three times 7 exceeds 16 by 5.

ALIQUOT *part*, is such part of a number as will divide and measure it exactly, without any remainder. For instance, 2 is an aliquot part of 4, 3 of 9, and 4 of 16.

To find all the aliquot parts of a number, divide it by its least divisor, and the quotient by its least divisor, until you get a quotient not farther divisible, and you will have all the prime divisors or aliquot parts of that number. Thus, 60, divided by 2, gives the quotient 30, which divided by 2 gives 15, and 15 divided by 3, gives the indivisible quotient 5. Hence the prime aliquot parts are 1, 2, 2, 3, 5; and by multiplying any two or three of these together, you will find the compound aliquot parts, viz. 4, 6, 10, 12, 15, 20, 30.

Aliquot parts must not be confounded with commensurable ones; for though the former be all commensurable, yet these are not always aliquot parts: thus 4 is commensurable with 6, but is not an aliquot part of it.

ALISMA, *great water plantain*, in botany, a genus of the Hexandria Polyginia class of plants, the calyx of which is a perianthium composed of three oval, hollow, permanent leaves; the corolla consists of three, large, roundish, plane, and very patent petals; the fruit consists of capsules, arranged together in a roundish or trigonal form: the seeds are single and small. There are nine species.

ALKAHEST, or ALCAHEST, among chemists, denotes an universal menstruum capable of resolving all bodies into their *ens primum*, or first matter; and that without suffering any change, or diminution of force by so doing. See ALCHEMY.

ALKALI, in chemistry, a word applied to all bodies that possess the following properties: they change vegetable blue colours, as that of an infusion of violets, to green: they have an acrid and peculiar taste: they serve as intermedia between oils and water: they are capable of combining with acids, and of destroying their acidity: they corrode woollen cloth, and, if the solution be sufficiently strong, reduce it to jelly: and they are soluble in water. The alkalies at present known are three; viz. ammonia, potash, and soda: the two last are called *fixed* alkalies, because they require a red heat to volatilize them; the other is denominated *volatile* alkali, because it readily assumes a gaseous form, and is dissipated by a very moderate degree of heat. Barytes, strontian, lime, and magnesia, have been denominated alkalies by Fourcroy; but as they possess the striking character of earths in their fixity, this innovation does not seem entitled to general adoption.

Since writing the above, some discoveries of great importance, on the subject of alkalies, have been made known to the philosophical world by Mr. Davy, Professor of Chemistry at the Royal Institution. We shall in this place give a sketch of the two papers which he has just laid before the Royal Society, referring to some subsequent articles for further particulars. In a former discourse read before this learned body, Mr. Davy, in speaking of the agencies of electricity, suggested the probability that other bodies not then enumerated might be decomposed by the electric fluid. In the course of the last summer, this celebrated philosopher was employed in making a number of experiments with this particular view, and by means of very powerful galvanic troughs, consisting of a hundred pair of plates, six inches square, and one hundred and fifty pair four inches square, he has succeeded in decomposing potash and soda. A more brilliant discovery has not been made since those which have immortalized the names of Priestley and Cavendish. This was effected by placing moistened potash, or soda, on a plate of platina, and exposing it to the galvanic circle. Oxygen was disengaged, and the alkalies reduced to their primitive base, which is found to be a peculiar and highly-inflammable matter, and which assumes the form and appearance of small globules of mercury. These globules are, however, lighter than water, and when potash is used, they are in the proportion of 6 to 10. At the freezing point they are hard and brittle;

and when broken, and examined by a microscope, they present a number of facettes with the appearance of crystallization: at 40° Fahrenheit they are soft, and can scarcely be discriminated but by their gravity from globules of mercury; at 60° they are fluid, and at the small heat of 100° volatile. When exposed to the atmosphere, they rapidly imbibe oxygen, and reassume the alkaline character. In distilled naptha they may be preserved four or five days, but if exposed to the atmosphere, they almost instantly become incrusted with a coat of alkali: the incrustation may be removed, and the reduced globule will remain, either in naptha, or otherwise separated from all contact with oxygen. See BITUMEN.

One part of the base of alkali and two of mercury, estimated by bulk, form an amalgam, which when applied in the circle of a galvanic battery, producing an intense heat, to iron, silver, gold, or platina, immediately dissolved them, and converted them into oxides, in which process alkali was regenerated. Glass, as well as all other metallic bodies, was also dissolved by the application of this substance: the base of the alkali seizing the oxygen of the manganese and of the minium, potash was regenerated. One of these globules placed on a piece of ice dissolved it, and burnt with a bright flame, giving out an intense heat. Potash was found in the product of the dissolved ice. Nearly the same effects followed, when a globule was thrown into water: in both cases a great quantity of hydrogen was rapidly liberated. When laid on a piece of moistened turmeric paper, the globule seemed instantly to acquire an intense heat; but so rapid was its movement in quest of the moisture, that no part of the paper was burnt, only an intense deep red stain marked the course it followed, and showed a reproduction of alkali. The specific gravity of the base of soda is as seven to ten of water: it is fixed in a temperature of about 150°, and fluid at 180°. Mr. Davy next tried its effects on the phosphates, phosphurets, and many other salts of the first and second degree of oxydizement, all of which it decomposed, seizing their oxygen, and reassuming its alkaline qualities. From many experiments it appears, that 100 parts of pot-ash contain 15 of oxygen and 85 of an inflammable base, and that the same quantity of soda contains 20 of oxygen and 80 base. This ingenious chemist, after a great number of complex experiments, in which he was assisted by Messrs. Pepys and Allen, ascertained that oxygen is also an essential ingredient in ammonia; of which 100 grains appeared to yield 20 of oxygen. Mr. Davy has also found that oxygen is one of the constituent principles of the muriatic and fluoric acids; and likewise of the earths barytes and strontites. See CHEMISTRY, POTASH, and SODA.

ALLAMANDA, in botany, a genus of the Pentandria Monogynia class and order: corolla twisted; capsule lens-form, erect, echinate, one-celled, two-valved, many-seeded. One species, viz. cathartica, a climbing plant, found in Guiana. The infusion of its leaves is used in the cholic.

ALLANTOIS, or ALLANTOIDES, in comparative anatomy, a vesicle investing the fœtus of several animals, as cows, sheep, goats, &c. and filled with an urinous liquor conveyed thither from the urachus.

ALLEGIANCE, is the lawful duty from the subject to the sovereign; and is either natural, as every subject born ought to pay; acquired, where a man is naturalized; local, which a man ought to pay who comes under the dominion of the king.

ALLEGORY, in matters of literature, a mode or species of writing, wherein something else is signified than the words in their literal meaning express. An allegory may be considered as a series or chain of metaphors, continued through a whole discourse. For example, when the prophets represent the Jews under the allegory of a vine planted, cultivated and watered by the hand of God, which instead of producing good fruit, brings forth verjuice and sour grapes.

ALLEGRO, in music, an Italian word denoting that the part is to be played in a sprightly, brisk, lively, and gay manner. Allegros move swifter in triple than in common time. Sometimes in conjunction with another word, placed at the beginning of compositions, it is intended to rouze and stimulate the more violent passions.

ALLEMANDE, in music, a slow air or melody in common time of four crotchets in a bar. A species of composition, supposed from its name to be of German origin. It is found in Handel's harpsichord lessons, and other works of about that date; but as a sonata movement it is now obsolete. The dance known by this name is still used in Germany and Switzerland, and is written in common time of two crotchets in bar.

ALLEN (THOMAS) a celebrated mathe

matician of the 16th century. He was born at Uttoxeter in Staffordshire, in 1542; was admitted a scholar of Trinity College, Oxford, in 1561; where he took his degree of master of arts in 1567. In 1570 he quitted his college and fellowship, and retired to Gloucester Hall, where he studied very closely, and became famous for his knowledge in antiquities, philosophy, and mathematics. He received an invitation from Henry, Earl of Northumberland, a great friend and patron of the mathematicians, and he spent some time at the Earl's house; where he became acquainted with those celebrated mathematicians, Thomas Harriot, John Dee, Walter Warner, and Nathaniel Torporley. Robert, Earl of Leicester, too, had a great esteem for Allen, and would have conferred a bishopric upon him; but his love for solitude and retirement made him decline the offer. His great skill in the mathematics gave occasion to the ignorant and vulgar to look upon him as a magician or conjurer. Allen was very curious and indefatigable in collecting scattered manuscripts relating to history, antiquity, astronomy, philosophy, and mathematics: which collections have been quoted by several learned authors, and mentioned as in the Bibliotheca Alleniana. He published in Latin the second and third books of Ptolemy, "Concerning the Judgment of the Stars, or, as it is usually called, of the quadripartite construction, with an exposition. He wrote also notes on many of Lilly's books, and some on John Bale's work, "De Scriptoribus Mag. Britanniæ." He died at Gloucester Hall in 1632, being 90 years of age.

Mr. Burton, the author of his funeral oration, calls him "the very soul and sun of all the mathematicians of his age." And Selden mentions him as a person of the most extensive learning and consummate judgment, the brightest ornament of the university of Oxford. Also Camden says he was skilled in most of the best arts and sciences. A. Wood has also transcribed part of his character from a manuscript in the library of Trinity College, in these words: "He studied polite literature with great application; he was strictly tenacious of academic discipline, always highly esteemed both by foreigners and those of the university, and by all of the highest stations of the church of England, and the university of Oxford. He was a sagacious observer, an agreeable companion," &c.

ALLIGATION, in arithmetic, is the rule of mixture, which teaches to compound several species of ingredients or commodities together, according to any intent or design proposed; and is either medial or alternate.

Alligation *medial* shews the rate or price of any mixtures, when the several quantities of the mixture, and their rates, are known.

Rule: multiply each quantity given, by the price; and then, by direct proportion, say, as the sum of the quantities given, to the sum of the products; so is any part of the mixture, to the value of that part. Example: a goldsmith melts 3 ounces of gold, at 4*l.* 6*s.* 8*d.* per ounce, with 12 ounces at 4*l.* per ounce, and 8 ounces at 4*l.* 5*s.* per ounce: when they are all melted together, one ounce will be found to be worth 4*l.* 2*s.* $\frac{7}{23}$*d.* Thus,

oz.		*l.*	*s.*	*d.*		*l.*
3	at	4	6	8	multiplied together produce	13
12		4	0	0		48
8		4	5	0		34
23 Sum						Sum 95

oz. *l.* *oz.* *l.* *s.* *d.*
Then as 23 : 95 :: 1 : 4 2 7$\frac{7}{23}$ Ans.

Alligation *alternate* teaches to mix goods, of different prices, in such proportion, that the mixture may be sold for any price proposed.

Rule: set down the names of the things to be mixed, together with their prices; then, finding the difference between each of these, and the proposed price of the mixture, place these differences in an alternate order, and they will shew the proportion of the ingredients.

ALLIONIA, in botany, so called in honour of Charles Allioni, professor of botany at Turin, a genus of the Tetrandria Monogynia class and order, of the natural order of Aggregatæ; the calyx is a perianthium common to three flowers; and the perianthium proper is obsolete superior; the corollæ proper, one-petalled, funnel-shaped, and erect: the stamina have setaceous filaments; anthers roundish; the pistillum has a germ inferior, oblong, style setaceous, longer than the stamens, stigma multifid and linear, no pericarpium; seeds solitary, the receptacle naked. There are three species.

ALLIOTH, a star in the tail of the Greater Bear, much used for finding the latitude at sea.

ALLITERATION, in rhetoric, is a figure or decoration in language, chiefly used in poetry, and consisting in the repetition

of the same letter or letters at certain intervals, whence the name is derived.

ALLIUM, *garlic*, in botany, a genus of the Hexandria Monogynia class and order; the calyx is a common sheath, and many-flowered, the corolla consists of six oblong petals: the stamina have six filaments, generally of the length of the corolla, the anthers are oblong and upright; the pistillum has a a germ, superior, short, bluntly three-cornered: the pericarpium is a capsule, short, broad, three-celled and three-valved; the seeds are many and round. There are 53 species distributed into several divisions. The common garlic has a large round white bulbous root, of an irregular form, with numerous fibres at the bottom, composed of many smaller bulbs denominated cloves, which are included in a common membranous covering, each of which being planted, grows, and in one season attains the size and structure of the parent bulb; the leaves are cauline, or form a kind of stalk, which seldom spindles, except when the same roots remain in the ground two or three years, when they run up and bear a flower and small bulbs at the top. It deserves to be cultivated in the garden for the sake of its root, which is in great estimation for culinary and other domestic purposes. Indeed, the roots, as well as all the other parts of the plant, have a very acrid taste, with an highly-offensive smell, which has rendered its cultivation in gardens less desirable. It is a hardy plant, capable of growing in most sorts of soils and situations, and readily propagated either by roots or seeds.

Rocambole has very small compound bulbs, which grow in clusters; the stalk generally spindling two or three feet high, with many bulbs at its summit, which, as well as the root bulbs, are useful for the same purposes as garlic, though much inferior. The latter, or the flowery kinds, have the flower-stems rising immediately from the root, growing erect and attaining different heights, from twelve to thirty inches; in some the leaves are radical, in others cauline, or elevated with the stalk, some are broad like those of a tulip, others long and narrow like a daffodil, and some taper and rush-like; but in all the sorts the stems are terminated by a sort of sheath, from which is protruded an aggregate of many small flowers, forming a kind of umbel. The flowers singly are composed each of six petals, which, though separately small, from many being collected into large heads, are very conspicuous. Of the second division, or the onion kind, the characters. &c. of which are the same as those of garlic, the species are these: 1. Cepa, or common onion; the best garden varieties of which are the Strasburgh or common round onion, the oval or long-keeping common onion, the Spanish large flat onion, the Spanish silken-skinned onion, the Spanish red-skinned onion, and the Portugal great roundish oval onion. 2. Fistulosum, or the ciboule or Welsh onion. 3. Schænoprasum, cives or chives. 4. Ascalonicum, eschalot or schallot. 5. Canadense, or Canada-tree onion. All the first species and varieties have large bulbous roots, and the plants are biennial, or being sown in the spring, arrive at perfection in the root the same year, and next year shoot up into stalk, flower, and ripen seed, when the stalks quickly die, and the individuals are annihilated. But the second and third species never form any bulbs at bottom; they are, however, hardy and perennial, and may be continued many years. And the fourth and fifth species are bulbous-rooted perennials, multiplying greatly by off-sets, as is evident from their culture.

Ciboule or Welsh onion. This is a perennial plant, which never forms any bulb at bottom; therefore deserves to be cultivated only to be drawn as young green onions for salads, &c. in spring; but on account of its strong taste it is greatly inferior to those of the common onion. From the plants being so extremely hardy as to survive the severest winter, in which, though their blades be cut off, the roots remain sound, and shoot forth with great vigour early in spring, furnishing seasonable supplies till May, when they generally run to seed. From this singular hardiness they may be cultivated more or less as a winter standing crop, with advantage, for spring use.

Cives or chives. This is the smallest of all the onion kind, rising but a few inches high; but its roots are perennial, and increase considerably into clusters, from which large tufts of slender awl-shaped leaves issue, which are the principal part used, the roots never forming any bulb, at least not bigger than small peas. This is a hardy plant, which merits a place in every garden, Its clusters of leaves rise early in spring, and are useful both in salads and for culinary purposes, in default of onions. The method of gathering it is to cut the leaves off near the ground, by which a fresh supply is soon produced from the bottom; or occasionally the plants in clusters may be slipped quite to the root in separate little

plants, resembling young onions, and used as substitutes for them. It is easily increased by dividing the roots in spring, and planting eight or ten of them together in holes, at six inches distance; in this way, by autumn, they will multiply into bunches of a large size.

Escalot or shallot. This is a species of onion which is bulbous-rooted, and which increases greatly by off-sets, the largest of which are the proper parts of the plant for use. The bulbs are oblong, irregular, and seldom grow large; as they generally increase into clusters, they do not swell like roots that grow singly. From the roots are produced many long, narrow, infirm leaves in the spring, and which wither in July or August, when the roots are full grown; they are then taken up, made dry and housed, when they keep in good perfection till the following spring.

Canada or tree-onion. This deserves to be cultivated, both as a curiosity in producing the onion at the top of the stalk, and for the use of the onions, especially for pickling, in which they are excellent and superior in flavour to the common onion. It is perennial, and propagated by planting the bulbs in spring or autumn. Either the root bulbs, or those produced on the top of the stalk, being planted in a bed or beds of any good earth, in rows a foot asunder, six inches distance in each row, and two or three inches deep, they shoot up leaves and stalks in the spring and summer, and produce the bulbs for use in July or August; and the root-bulbs remaining, furnish a production of top-bulbs, annually in that season; the root-bulb increasing by off-sets, may be taken up occasionally at the time the stem decays in autumn; or once in two or three years, in order to separate the off-sets, and replant them when necessary.

The leek is the third division of the genus, the general characters of which are the same as those before described, and the species and varieties are the porrum, or common leek, which may be said to be an annual-biennial plant, for although the roots often survive after perfecting seeds, yet the plants always attain perfection the same year they are sown, and the year afterwards run up to stalk, and become unfit for use. The seed-stalk of this plant does not belly like that of the onion. The best of the varieties of this plant for general culture is the broad-leaved or London leek, which attains a large growth, the neck acquiring a thick substance, in length from six to nine or ten inches, dividing upwards into many large, long, thick leaves, arranging themselves in somewhat a fan-shape.

ALLODIAL, an epithet given to an inheritance held without any acknowledgment to a lord or superior, in opposition to feudal.

ALLODIUM, or ALLEUD, denotes lands which are the absolute property of their owner, without being obliged to pay any service or acknowledgment whatever to a superior lord; in which sense they stand opposed to feudal lands, which pay a fee to some supérior.

ALLOPHYLUS, in botany, a genus of the Octandria Monogynia class of plants, the calyx of which is a perianthium composed of four leaves of an orbicular figure, and two opposite ones smaller than the others; the corolla consists of four petals less than the cup, of an orbicular figure, and equal one to another, with large ungues of the same length with the smaller leaves of the cup. There are three species: A. zeylanicus is a tree having the appearance of persea, and a native of Ceylon. A cominia rises 30 feet in height, with a stem as thick as a man's thigh, with numerous flowers, to which succeed berries the size of a pin's head, with shell and kernel: grows plentifully in Jamaica. A. ternatus is a native of Cochin China.

ALLOY, or ALLAY, a proportion of a baser metal mixed with a finer one. Thus, all gold coin has an alloy of silver and copper, as silver coin has of copper alone; the proportion in the former case, for standard gold, being two carrats of alloy in a pound troy of gold; and in the latter 18 pennyweights of alloy for a pound troy of silver.

According as gold or silver has more or less alloy than that mentioned above, it is said to be coarser or finer than the standard. However, it ought to be remarked, that the coin of different nations varies greatly in this respect; some using a larger, and others a less proportion of alloy, the original intention of which was to give the coin a due degree of hardness.

ALLOY, in a chemical sense, may be defined a combination of two or more metals into one homogeneous mass, not separable from each other by mere heat. The most valuable and useful of these are brass, type-metal, tutenag, bronze, speculum-metal, for which see the different articles. If two metals being fused together produce a mass, whose specific gravity is either greater or less than the mean specific gravity of its

elements, the result is an alloy, or proper chemical combination. One of the most striking proofs of actual combination between the parts of an alloy, is a remarkable increase of fusibility. This, in almost all cases, is much greater than could be inferred from the mean fusibility of its component parts. Thus, equal parts of tin and iron will melt at the same temperature as is required for equal parts of tin and copper, notwithstanding the great difference between the fusing heat of copper and iron, when they are each of them pure. So also an alloy of tin, bismuth, and lead, in the proportion of 3, 8, and 5, will melt in boiling water, which is a less heat than is necessary for the liquefaction of bismuth, the most fusible of the three. The oxydability of an alloy is generally either greater or less than that of the unmixed metals. Tin and lead mixed will, at a low red heat, take fire and oxydate immediately.

ALLUSION, in rhetoric, a figure by which something is applied to, or understood of another, on account of some similitude between them.

ALLUVIAL, by alluvial depositions is meant the soil which has been formed by the destruction of mountains, and the washing down of their particles by torrents of water. The alluvial formations constitute the great mass of the earth's surface. They have been formed by the gradual action of rain or river water upon the other formations. They may be divided into two kinds, viz. those deposited in the valleys and mountainous districts, or upon elevated plains, which often occur in mountains; and those deposited upon flat land. The first kind consists of sand, gravel, &c. which constituted the more solid parts of the neighbouring mountains, and which remained when the less solid parts have been washed away. They sometimes contain ores, particularly gold and tin, which existed in the neighbouring mountains. The second kind consists of loam, clay, sand, turf, and calctuff. Here are also earth and brown coal in which amber is found, wood coal, bituminous wood, and bog-iron ore. The sand contains some metals. The calctuff contains plants, roots, moss-bones, &c. which it has incrusted. The clay and sand often contain petrified wood, and skeletons of quadrupeds.

ALLUVION, among civilians, denotes the gradual increase of land along the sea-shore, or on the banks of rivers. This, when slow and imperceptible, is deemed a lawful means of acquisition; but when a considerable portion of land is torn away at once by the violence of the current, and joined to a neighbouring estate, it may be claimed again by the former owner.

ALMAGEST, the name of a celebrated book composed by Ptolemy; being a collection of a great number of the observations and problems of the ancients, relating to geometry and astronomy; but especially the latter. And being the first work of this kind which has come down to us, and containing a catalogue of the fixed stars, with their places, beside numerous records and observations of eclipses, the motions of the planets, &c. it will ever be held dear and valuable to the cultivators of astronomy. See PTOLEMY.

In the original Greek it is called συνταξις μεγιστη, the "great composition" or "collection." And to the word μεγιστη the Arabians joined the particle "al," and thence called it "Almaghesti," or, as we call it, from them, the Almagest.

ALMAMON, Caliph of Bagdat, a philosopher and astronomer in the beginning of the ninth century, he having ascended the throne in the year 814. He was son of Harun Al-Rashid, and grandson of Almansor. Having been educated with great care, and with a love for the liberal sciences, he applied himself to cultivate and encourage them in his own country. For this purpose he requested the Greek emperors to supply him with such books of philosophy as they had among them; and he collected skilful interpreters to translate them into the Arabic language. He also encouraged his subjects to study them; frequenting the meetings of the learned, and assisting at their exercises and deliberations. He formed a college at Khorasan, and selected to preside over it Mesul of Damascus, a famous Christian physician. When his father, who was still living, remonstrated against the appointment, on account of the president's religion, he replied, that he had chosen him, not as a teacher of theology, but for the instruction of his subjects in science and the useful arts, and that his father well knew, that the most learned men and skilful artists in his dominions were Jews and Christians. He caused Ptolemy's Almagest to be translated in 827, by Isaac Ben-honain, and Thabet Ben-korah, according to Herbelot, but according to others by Sergius, and Alhazen, the son of Joseph. In his reign, and doubtless by his encouragement, an astronomer of Bagdat, named Habash, composed three sets of astronomical tables.

Almamon himself made many astronomical observations, and determined the obliquity of the ecliptic to be then 23° 35′, or 23° 33′ in some manuscripts, but Vossius says 23° 51′ or 23° 34′. He also caused skilful observers so procure proper instruments to be made, and to exercise themselves in astronomical observations; which they did accordingly at Shemasi in the province of Bagdat, and upon Mount Casius, near Damas.

Under the auspices of Mamon also a degree of the meridian was measured on the plains of Sinjar, or Sindgiar, upon the borders of the Red Sea; by which the degree was found to contain $56\frac{2}{3}$ miles, of 4000 coudees each, the coudee being a foot and a half: but it is not known what foot is here meant, whether the Roman, the Alexandrian, or some other. Abulfeda says that this cubit contained 27 inches, each inch being determined by six grains of barley placed sideways; but Thevenot says, that 144 grains of barley placed in this manner would give a length equal to $1\frac{1}{2}$ Paris foot: four cubits would be equal to one toise and nine inches, and therefore 4000 cubits, that is $56\frac{2}{3}$ miles, would give 63,730 toises. But if the ordinary cubit of 24 inches was the measure to which the calculation is to be referred, the degree, in this estimate of it, would contain 56,666 toises. According to another valuation of a cubit, this measure would consist of 53,123 French toises.

Almamon was a liberal and zealous encourager of science, in consequence of which the Saracens began to acquire a degree of civilization and refinement to which they had formerly been strangers. The liberality of his mind obtained for Almamon the reputation of infidelity. But whatever opinions he might hold respecting the Koran, he seems to have had a confidence and trust in the Supreme Being. In this work we shall not follow the caliph into the field of battle, nor record his victories, which were brilliant and important. We must look to him in the character of a philosopher and man of science, and in addition to what has already been noticed, we may remark, that he built a new nilometer, for measuring the increase of the Nile, and repaired one that was gone to decay. In the year 833, as he was returning from one of his expeditions, he unwarily quenched his thirst, while very much heated by exercise, with cold water, which brought on a disorder that terminated his life. During his last illness, he settled the affairs of the state, and then exclaiming in the spirit of piety, "O thou who never diest, have mercy on me, a dying man." He expired at the age of 49, after a reign of 20 years. He was interred at Tarsus. To the principles of science, and not to those of the Mohammedan religion, have been ascribed the liberality and benignity of temper which he displayed in certain trying circumstances. When his uncle and rival Ibrahim was taken, brought to trial, and condemned, the caliph, instead of sanctioning the sentence, tenderly embraced his relation, saying, "Uncle, be of good cheer, I will do you no injury:" and he not only pardoned him; but granted him a rank and fortune suitable to his birth. Being complimented on account of this generous deed, he exclaimed, "Did but men know the pleasure that I feel in pardoning, all who have offended me would come and confess their faults." Almamon in the course of his reign, employed the most skilful astronomers that he could find to compose a body of astronomical science, which still subsists among oriental MSS. entitled, "Astronomia elaborata à compluribus D. D. jussu regis Maimon."

ALMANAC, in matters of literature, a table containing the calendar of days and months, the rising and setting of the sun, the age of the moon, &c.

Authors are neither agreed about the inventor of almanacs, nor the etymology of the word; some deriving it from the Arabic particle *al*, and *manah*, to count; whilst others think it comes from *almanah*, *i. e.* handsels, or new year's gifts, because the astrologers of Arabia used, at the beginning of the year, to make presents of their ephemerides for the year ensuing.

As to the antiquity of almanacs, Ducange informs us, that the Egyptian astrologers, long before the Arabians, used the term *almenach*, and *almenachica descriptio*, for their monthly predictions. Be this as it will, Regiomontanus is allowed to have been the first who reduced almanacs to their present form.

ALMANACS, *construction of.* The first thing to be done, is to compute the sun's and moon's place for each day in the year, or it may be taken from some ephemerides and entered in the almanac; next, find the dominical letter, and, by means thereof, distribute the calendar into weeks: then, having computed the time of Easter, by it fix the other moveable feasts; adding the immoveable ones, with the names of the martyrs, the rising and setting of each luminary, the

length of day and night, the aspects of the planets, the phases of the moon, and the sun's entrance into the cardinal points of the eliptic, *i. e.* the two equinoxes and solstices.

These are the principal contents of almanacs; besides which there are others of a political nature, and consequently different in different countries, as the birth-days and coronation of princes, tables of interest, &c.

On the whole, there appears to be no mystery, or even difficulty, in almanac-making, provided tables of the heavenly motions be not wanting. For the duties upon almanacs, see STAMP-DUTIES.

ALMANAC, *nautical, and astronomical ephemeris*, is a kind of national almanac, published annually by anticipation, under the direction of the commissioners of longitude. Besides every thing essential to general use that is to be found in other almanacs, it contains, among other particulars, the distances of the moon from the sun and fixed stars for every three hours of apparent time, adapted to the meridian of Greenwich, by comparing which with the distances carefully observed at sea, the mariner may readily infer his longitude to a degree of exactness, that may be thought sufficient for most nautical purposes. The publication of it is chiefly designed to facilitate the use of Mayer's lunar tables, by superseding the necessity of intricate calculations in determining the longitude at sea.

ALMANAC, is part of the law of England, of which the courts must take notice in the returning of writs; but the almanac to go by is that annexed to the Book of Common Prayer. An almanac in which the father had written the day of the nativity of his son was allowed as evidence, to prove the nonage of his son.

ALMOND-*tree*, in botany. See AMYGDALUS.

ALMUCANTARS, in astronomy, an Arabic word denoting circles of the sphere passing through the centre of the sun, or a star, parallel to the horizon, being the same as parallels of altitude.

Almucantars are the same with respect to the azimuths and horizon, that the parallels of latitude are with regard to the meridians and equator. They serve to shew the height of the sun and stars, and are described on many quadrants, &c.

ALNAGE, or AULNAGE, in the English polity, the measuring of woollen manufactures, with an ell, and the other functions of the alnager. See the next article. Alnage was at first intended as a proof of the goodness of the commodity, and therefore a seal was invented as a signal that the commodity was made according to the statute.

ALNAGER, in the English polity, a public sworn officer, whose business is to examine into the assize of all woollen cloth made throughout the kingdom, and to fix seals upon them. Another branch of his office is to collect an alnage duty to the king. See the last article.

There are now three officers relating to the alnage, namely, a searcher, measurer, and alnager; all which were formerly comprized in the alnager, until by his own neglect it was thought proper to separate these offices.

ALNUS, the *alder-tree*, in botany. See BETULA.

ALOE, in botany, a genus of the Hexandria Monogynia class of plants, with a liliaceous flower, consisting of only one tubular leaf, divided into six deep segments at the edge: its fruit is an oblong capsule, divided into three cells, and containing a number of angulated seeds. There are 16 species.

Several species of this exotic plant are cultivated in the gardens of the curious, where they afford a very pleasing variety, as well by the odd shape of their leaves as by the different spots with which they are variegated.

Some aloes are arborescent, or divided into a number of branches, like trees; others are very small, growing close to the ground. The two most considerable species are the aloe of America, and that of Asia; the former on account of its beautiful flowers, and the latter for the drug prepared from it.

All the aloes are natives of hot climates; and the place of growth of most of them is the Cape of Good Hope. The Hottentots hollow out the trunk of the first species, or A. dichotoma, to make quivers for their arrows; and several of them are used for hedges. Among the Mahometans, and particularly in Egypt, the aloe is a kind of symbolic plant, and dedicated to the offices of religion: for pilgrims, on their return from Mecca, suspend it over their doors as an evidence of their having performed that holy journey. The superstitious Egyptians imagine, that it has the virtue of keeping off apparitions and evil spirits from their houses, and it is hung over the doors of Christians and Jews in Cairo for this purpose. They also distil from it a water, which is sold in the shops, and recommended in coughs, asthmas, and hysterics. Hasselquist men-

tions a person who was cured of the jaundice in four days by taking about half a pint of it. The Arabians call it sabbara. The negroes, as we are informed by Adanson, in his voyage to Senegal, make very good ropes of the leaves of the Guinea aloes, which are not apt to rot in water. M. Fabroni, as we learn from the Annales de Chimie, procured from the leaves of the aloe succotrina angustifolia a violet dye, which resists the action of oxygen, acids, and alkalies. This juice, he says, produces a superb transparent colour, which is highly proper for works in miniature, and which, when dissolved in water, may serve, either cold or warm, for dying silk from the lightest to the darkest shade: and he reckons it one of the most durable colours known in nature. Aloes was used among the ancients, in embalming, to preserve bodies from putrefaction. Of this species of aloes, interpreters understand that to have been which Nicodemus brought to embalm the body of Christ. John xix. 3. Aloes, whose resinous part is not soluble in water, has been used as a preservative to ships' bottoms against the worms, to which those that trade to the East and West Indies are particularly subject. One ounce of aloes is sufficient for two superficial feet of plank; about 12 lb. for a vessel of 50 tons burthen, and 300 lb. for a first rate man of war. It may be incorporated with six pounds of pitch, one of Spanish brown, or whiting, and a quart of oil; or with the same proportion of turpentine, Spanish brown, and tallow. Such a coat, it has been said, will preserve a ship's bottom eight months, and the expense for a first-rate ship will be about 18*l.* The same composition may be used in hot countries for preserving rafters, &c. from the wood-ant. The efficacy of aloes, as a defence against worms, has been controverted.

Aloe, or Aloes, in pharmacy, the inspissated juice of the aloe perfoliata, asiatic aloe, prepared in the following manner: from the leaves, fresh pulled, is pressed a juice, the thinner and purer part of which is poured off, and set in the sun to evaporate to a hard yellowish substance, which is called *succotrine aloe*, as being chiefly made at Succotra. The thicker part, being put into another vessel, hardens into a substance of a liver-colour, and thence called *aloe hepatica.* The thickest part, or sediment, hardens into a coarse substance, called *aloe cabalina*, or the horse-aloe, as being chiefly used as a purge for horses.

Fabroni has discovered that the recent juice of the leaves of the aloe has the property of absorbing oxygen, of assuming a fine reddish purple, and of yielding a pigment which he strongly recommends to the artist.

ALOPECURUS, *fox-tail-grass*, in botany, a genus of the Triandria Digynia class of plants, and of the natural order of Grasses, the calyx of which is a bivalve glume, containing a single flower: the valves are hollow, of an ovate lanceolated figure, equal in size, and compressed; the corolla is univalve; the valve is concave, and of the length of the cup, and has a very long arista inserted into its back near the base. There is no pericarpium: the corolla itself remains, and contains the seed, which is single and of a roundish figure. There are 12 species. The A. pratensis, meadow foxtail, is a native of most parts of Europe, and is found with us very common in pastures and meadows. It is perennial, and flowers in May. This is the best grass to be sown in low meadow grounds, or in boggy places which have been drained. It is grateful to cattle, and possesses the three great requisities of quantity, quality, and earliness, in a degree superior to any other, and is therefore highly deserving of cultivation in lands that are proper for it. The seed may be easily collected, as it does not quit the chaff, and the spikes are very prolific; but the larvæ of a species of muscæ, which are themselves the prey of the cimex campestris, devour the seeds so much, that in many spikes scarcely one is found perfect. A. agrestis is a very troublesome weed in cultivated ground, and among wheat it is execrated by farmers, under the name of black-bent; it is also common by way-sides, as well as in corn-fields, and in pastures in the Isle of Wight. It has acquired the name of mouse-tail grass in English, from the great length and slenderness of the spike, which resembles the tail of a mouse. It is annual, and flowers in July, continues flowering till autumn, and comes into bloom very soon after being sown.

ALPHABET, in matters of literature, the natural or accustomed series of the several letters of a language.

As alphabets were not contrived with design, or according to the just rules of analogy and reason, but have been successively framed, and altered, as occasion required, it is not surprizing that many grievous complaints have been heard of their deficiencies, and divers attempts made to establish new and more adequate ones in their place.

All the alphabets extant are charged by Bishop Wilkins with great irregularities, with respect both to order, number, power, figure, &c.

As to the order, it appears (says he) inartificial, precarious, and confused, as the vowels and consonants are not reduced into classes, with such order of precedence and subsequence as their natures will bear. Of this imperfection the Greek alphabet, which is one of the least defective, is far from being free: for instance, the Greeks should have separated the consonants from the vowels; after the vowels they should have placed the dipthongs, and then the consonants; whereas in fact, the order is so perverted that we find the ομικρον the fifteenth letter, in order of the alphabet, and the ωμεγα, or long o, the twenty-fourth and last, the ε the fifth, and the η the seventh.

With respect to number, they are both redundant and deficient; redundant, by allotting the same sound to several letters, as in the latin *c* and *k*, *f* and *ph*; or by reckoning double letters among the simple elements of speech, as in the Greek ξ and ψ, the Latin *q* or *cu*, *x* or *ex*, and the *j* consonant; deficient in many respects, particularly with regard to vowels, of which seven or eight kinds are commonly used, though the Latin alphabet takes notice only of five. Add to this, that the difference among them, with regard to long and short, is not sufficiently provided against.

The powers, again, are not more exempt from confusion; the vowels, for instance, are generally acknowledged to have each of them several different sounds; and among the consonants we need only bring as evidence of their different pronunciation, the letter *c* in the word *circa*, and *g* in the word *negligence*. Hence it happens, that some words are differently written, though pronounced in the same manner, as *cessio* and *sessio*; and others are different in pronunciation, which are the same in writing, as *give*, *dare*, and *give*, *vinculum*.

Finally, the figures are but ill-concerted, there being nothing in the characters of the vowels answerable to the different manner of pronunciation; nor in the consonants analogous to their agreements or disagreements.

Alphabets of different nations vary in the number of their constituent letters. The English alphabet contains twenty-four letters, to which if *j* and *v* consonants are added, the sum will be twenty-six; the French, twenty-three; the Hebrew, Chaldee, Syriac, and Samaritan, twenty-two each; the Arabic, twenty-eight; the Persian, thirty-one; the Turkish, thirty-three; the Georgian, thirty-six; the Coptic, thirty-two; the Muscovite, forty-three; the Greek, twenty-four; the Latin, twenty-two; the Sclavonic, twenty-seven; the Dutch, twenty-six; the Spanish, twenty-seven; the Italian, twenty; the Ethiopic, as well as Tartarian, two hundred and two; the Indians of Bengal, twenty-one; the Baramos, nineteen; the Chinese, properly speaking, have no alpabet, except we call their whole language their alphabet: their letters are words, or rather hieroglyphics, and amount to about 80,000.

If alphabets had been constructed by able persons, after a full examination of the subject, they would not have been filled with such contradictions between the manner of writing and reading, as we have shewn above, nor with those imperfections that evidently appear in the alphabets of every nation. Mr. Lodowick, however, and Bishop Wilkins, have endeavoured to obviate all these, in their universal alphabets or characters. See Character.

It is no wonder that the number of letters in most languages should be so small, and that of words so great, since it appears that allowing only 24 letters to an alphabet, the different words or combinations that may be made out of them, taking them first one by one, then two by two, &c. &c. would amount to the following number:—1391, 724288, 887252, 999425, 128493, 4022000. See Combination. It must be admitted nevertheless, that the condition that every syllable must contain at least one vowel, would modify this number in the way of denomination; but on the other hand the combinations in polysyllabic words would operate the contrary way.

Many learned authors have composed inquiries into the origin of alphabetic writing, and not a few have referred the invention to the immediate inspiration of God. Nevertheless it appears to be a very simple and direct improvement of the heiroglyphic art. Sensible objects are depicted in outlines by children, and most rude nations; and, as in the construction of languages, so in this writing by figures, substantives will come to be used adjectively, to denote relations or qualities. As words become more complex and less perfect by the use of abstractions, so likewise must the hieroglyphic pictures become combined and imperfect, and at length must have denoted things very different from any object capable of being delineated: and among other conse-

quences, there is one very striking; namely, that the picture after degenerating into a sign or character, will be associated by memory with the oral character, or name, or correspondent word. An immediate step after this, must be that characters associated with monosyllabic words will be frequently put together to form polysyllabic words, in which the picture is left out of the consideration, and the sound alone forms the subject of the record, (as if the characters for man and eye were united to form the word many, or multitudinous.) And lastly, habit must in fact have given a preference in the composition of these polysyllabic words, to such simple sounds and their characters as were found to be most extensively useful. That is to say, an unintentional process of analysis must have thus given rise to the alphabet.

The sounds of language are modified by articulation, which depends on certain gross, and in general obvious changes in the figure of the organs; and by accent or mere intensity; and by intonation or music. The first of these, as used in discourse, is much more capable of having its variations marked by characters than the others; and from this circumstance it is found that the alphabet can deliver with correctness the words of such languages as communicate chiefly by articulation: but in languages where the same articulated monosyllable denotes a great variety of things according to the accent or intonation, there will be comparatively few instances of depicted sound, and the system of writing will continue to be hieroglyphic or rather symbolic in all its improvements. This system is for the reason here mentioned in use in China, and does not seem inferior to the alphabet, but in some respects more advantageous.

Alphabet is also used for a cypher, or table of the usual letters of the alphabet, with the corresponding secret characters, and other blank symbols intended to render the writing more difficult to be decyphered. See the article Decyphering.

Alphabet, among merchants, a kind of index, with the twenty-four letters, in their natural order, in which are set down the names of those who have opened accounts, referring to the folios of the ledger.

ALPHONSINE *tables*, astronomical tables calculated by order of Alphonsus, King of Castile, in the construction of which that Prince is supposed to have contributed his own labour.

ALPINIA, in botany, a genus of the Monandria Monogynia class of plants, the corolla whereof is monopetalous, unequal, and as it were double; the exterior one is trifid, the upper segment is hollow, the two side ones flat, and it has a tube; the interior is short, its edge is trifid, and the lower segment of the three hangs out beyond the lateral parts of the exterior corolla, the other two are emarginated, and the base is ventricose; the fruit is a fleshy capsule, of an ovated figure, composed of three valves, and containing three cells; the seeds are numerous, of an ovated figure, with a prominent but truncated apex, and a caudated base. There are seven species.

ALSINE, *chick-weed*, in botany, a genus of the Pentandria Trigynia class and order, and of the natural order of Caryophyllei: its characters are, that the calyx is a five-leaved perianthium, leaflets concave, oblong and acuminate; the corolla has five equal petals, longer than the calyx; the stamina consist of capillary filaments, the anthers roundish; the pistillum has a subovate germ, styles filiform, and stigmas obtuse; the pericarpium is an ovate, one-celled, three-valved capsule, covered with the calyx; the seeds are very many and roundish. There are five species, of which the following is the principal. A. media, common chick-weed, with petals bipartite, and leaves ovate cordate. The number of stamens in the flower of the common chick-weed is uncertain, from three to ten. This species in different soils and situations assumes different appearances; but it is distinguished from the cerastiums, which it most resembles, by the number of pistils, and by having the petals shorter than the leaves of the calyx, and from all the plants related to it, and particularly the stellaria nemorum, by having the stalk alternately hairy on one side only. Dr. Withering refers it to the stellaria, with which genus it agrees in various respects, and especially in the capsules opening with six valves. He observes, that it grows almost in all situations from damp and almost boggy woods, to the driest gravel walks in gardens; but in these various states its appearances are very different, so that those who have only taken notice of it as garden chicken-weed would hardly know it in woods, where it sometimes exceeds half a yard in height, and has leaves near two inches long, and more than one inch broad. In its truly wild state, he says, in damp woods, and hedge bottoms with a northern aspect, it has almost always ten stamens; but in drier

soils and more sunny exposures, the stamens are usually five or three. When the flowers first open, the peduncles are up right; as the flowers go off, they hang down; and when the seeds ripen, they again become upright. Dr. Withering observes, that the flowers are upright, and open from nine in the morning till noon; but if it rains, they do not open. After rain they become pendent; but in the course of a few days, rise again. In gardens or dunghills, chick-weed sheds abundance of seeds, which are round, compressed, yellow, and rough, with little tubercles; and thus becomes a troublesome weed; but if it be not suffered to seed, it may be destroyed, as it is annual, without much trouble. This species is a remarkable instance of the sleep of plants; for every night the leaves approach in pairs, including with their upper surfaces the tender rudiments of the new shoots; and the uppermost pair but one, at the end of the stalk, is furnished with longer leaf-stalks than the others, so that they can close upon the terminating pair, and protect the end of the branch. The young shoots and leaves, when boiled, can scarcely be distinguished from spring spinach, and are equally wholesome. Swine are very fond of it, cows and horses eat it; sheep are indifferent to it; and goats refuse it. This plant is found wild in most parts of the world. It is annual, and flowers almost through the whole year.

ALSTONIA, in botany, a genus of the Polyandria Monogynia class and order. Essen. char. corol. one-petalled, eight or ten-cleft: clefts alternated. There is but one species, a shrub found in South America. It is very smooth, and has the air of the bohea-tea, in the leaves, calyxes, and situations of the flowers. The dried leaves taste like those of Chinese tea.

ALSTROEMERIA, in botany, a genus of the Hexandria Monogynia class and order: cor. six-petalled, somewhat two-lipped; the lower petals tubular at the base: stamina declined. There are six species, all found in South America.

ALT in music, a term applied to that part of the great scale of sounds which lies between F above the treble-cleft note and G in altissimo.

ALTAR, a place upon which sacrifices were antiently offered to some deity.

The heathens at first made their altars only of turf; in following times they were made of stone, of marble, of wood, and even of horn, as that of Apollo in Delos. Altars differed in figure as well as in materials. Some were round, others square, and others oval. All of them were turned towards the east, and stood lower than the statues of the gods, and were generally adorned with sculpture, inscriptions, and the leaves and flowers of the particular tree consecrated to the deity. Thus, the altars of Jupiter were decked with oak, those of Apollo with laurel, those of Venus with myrtle, and those of Minerva with olive.

The height of altars also differed according to the different gods to whom they sacrificed. Those of the celestial gods were raised to a great height above the ground; those appointed for the terrestrial were almost on a level with the surface of the earth; and, on the contrary, they dug a hole for the altars of the infernal gods. According to Servius, the first were called *altaria*, the second *aræ*, and the last *crobiculi*; but this distinction is not every where observed, for we find in the best authors, the word *ara*, as a general word, including the altars of celestial, infernal, and terrestrial gods.

Before temples were in use, altars were erected sometimes in groves, sometimes in the high ways, and sometimes on the tops of mountains; and it was a custom to engrave upon them the name, proper ensign, or character of the deity to whom they were consecrated. Thus, St. Paul observed an altar at Athens, with an inscription *To the unknown God.*

In the great temples of ancient Rome, there were ordinarily three altars; the first was placed in the sanctuary, at the foot of the statue of the divinity, upon which incense was burnt, and libations offered: the second was before the gate of the temple, and upon it they sacrificed the victims: and the third was a portable altar, upon which were placed the offerings and the sacred vessels.

Besides these uses of the altars, the ancients swore upon them, and swore by them in making alliances, confirming treaties of peace, and on other solemn occasions. Altars also served as a place of refuge and sanctuary to all those who fled to them, whatever crime they had committed.

ALTAR is also used, among christians, for the communion-table.

ALTERNATE, in heraldry, is said in respect of the situation of the quarters.

Thus the first and fourth quarters, and the second and third, are usually of the same nature, and are called alternate quarters.

ALTERNATION is used for the different ways which any number of quantities may be changed, or combined. See COMBINATION.

ALTHÆA, *marsh-mallow*, in botany, a genus of plants, with a double calyx, the exterior one being divided into nine segments; the fruit consists of numerous capsules, each containing a single seed. It belongs to the Monadelphia Polyandria class and order. There are nine species. The A. officinalis is perennial, and flowers from July to September. It grows plentifully in salt marshes, and on the banks of rivers and ditches, in many parts of England, Holland, France, Italy, Siberia, &c. It has been in great request in every country where medicine has been regularly cultivated. All its parts abound with a glutinous juice with scarcely any smell or peculiar taste.

ALTIMETRY, denotes the art of measuring altitudes or heights. See MENSURATION.

ALTITUDE, in geometry, one of the three dimensions of body; being the same with what is otherwise called height.

Altitude of a figure is the distance of its vertex from its base, or the length of a perpendicular let fall from the vertex to the base.

Thales is supposed to have been the first person who applied the principles of geometry to the mensuration of altitude: by means of the staff he measured the height of the pyramids of Egypt, making the altitude of the staff and pyramid proportional to the length of the shadows.

ALTITUDE, in optics, is the height of an object above a line, drawn parallel to the horizon from the eye of the observer.

ALTITUDE *of the eye*, in perspective, is its perpendicular height above the geometrical plane.

ALTITUDE *of a star, &c.* in astronomy, is an arch of a vertical circle, intercepted between the stars and the horizon.

This altitude is either true or apparent, according as it is reckoned from the rational or sensible horizon, and the difference between these is what is called by astronomers the parallax of altitude. Near the horizon, this altitude is always increased by means of refraction.

ALTITUDE *of the mercury*, in the barometer and thermometer, is marked by degrees, or equal divisions, placed by the side of the tube of those instruments. The altitude of the mercury in the barometer in and about the metropolis is usually comprised between 28.4 and 30.6 inches: in the course of the last seven years it has not varied from these limits more than twice. During the same period, the thermometer in the shade has been rarely higher than 82° or 83°, and this seldom more than three or four times in a whole summer, nor often lower than about 8° or 10° below the freezing point. This degree of cold is not common.

ALTO-RELIEVO. See RELIEVO.

ALUM, in chemistry and the arts, is denominated the sulphate of alumina, though it is not merely a combination of alumina with the sulphuric acid. It possesses the following characters: 1. It has a sweetish astringent taste. 2. It is soluble in warm water, and the solution reddens vegetable colours, which proves the acid to be in excess. 3. When mixed with a solution of carbonate of potash, an effervescence is produced by the uncombined acid, which prevents the first portions of alkali, that are added to the solution of sulphate of alumina, from occasioning any precipitate. 4. When sulphate of alumina is heated, it swells up, loses its regular form, and becomes a dry, spongy mass; but according to the experiments of Vauquelin, the whole of its acid cannot be thus expelled. 5. The combination of sulphuric acid with alumina is incapable of crystallizing without an addition of potash, which makes a constituent part of all the alum of commerce. 6. It is decomposed by charcoal, which combines with the oxygen of the acid, and leaves the sulphur attached to the alumina.

Dr. Thomson says there are four varieties of alum, all of which are triple salts; two neutral, and two he calls super-salts. These are thus denominated:

1. Sulphate of alumina and potash.
2. Sulphate of alumina and ammonia.
3. Super-sulphate of alumina and potash.
4. Super-sulphate of alumina and ammonia.

The discovery of alum was made in Asia, from whence it continued to be imported till the end of the fifteenth century, when a number of alum works were established in Italy. In the sixteenth century it was manufactured in Germany and Spain; and during Queen Elizabeth's reign an alum manufactory was established in England. The alum of commerce is usually obtained from native mixtures of pyrites and clay, or sulphuric acid and clay. Bergman has published a very complete dissertation on the process usually followed. The earth from which it is procured is usually called aluminous shis-

tus, because it is slaty. Its colour is blackish, because it contains some bitumen. In most cases it is necessary to burn it before it can be employed: this is done by means of a slow smothered fire. Sometimes long exposure to the weather is sufficient to produce an efflorescence of alum on the surface. It is then lixiviated, and the water concentrated by evaporation, and mixed with putrid urine, or muriate of potash; crystals of alum and of sulphate of iron usually form together. The composition of alum has been but lately understood with accuracy. It has been long known, indeed, that one of its ingredients is sulphuric acid; and the experiments of Pott and Margraff proved incontestibly that alumina is another ingredient. But sulphuric acid and alumina are incapable of forming alum. Manufacturers knew that the addition of a quantity of potash or of ammonia, or of some substance containing these alkalies, is almost always necessary, and it was proved, that in every case in which such additions are unnecessary, the earth from which the alum is obtained contains already a quantity of potash. Various conjectures were made about the part which potash acts in this case; but Vauquelin and Chaptal appear to have been the first chemists that ascertained by decisive experiments that alum is a triple salt, composed of sulphuric acid, alumina, and potash or ammonia united together. Alum crystallizes in regular octahedrons, consisting of two four-sided pyramids applied base to base. The sides are equilateral triangles. The form of its integrant particles, according to Hauy, is the regular tetrahedron. Its taste is, as we have observed, astringent. It always reddens vegetable blues. Its specific gravity is 1.7109. At the temperature of 60° it is soluble in from 15 to 20 parts of water and in $\frac{3}{4}$ths of its weight of boiling water. When exposed to the air, it effloresces slightly. When exposed to a gentle heat it undergoes the watery fusion. A strong heat causes it to swell and foam, and to lose about 44 per cent. of its weight, consisting chiefly of water of crystallization. What remains is called calcined or burnt alum, and is sometimes used as a corrosive. By a violent heat, the greater part of the acid may be driven off. Though the properties of alum are in all cases pretty nearly the same, it has been demonstrated by Vauquelin that three varieties of it occur in commerce. The first is, super-sulphate of alumina and potash; the second, super-sulphate of alumina and ammonia; the third, is a mixture or combination of these two, and contains both potash and ammonia. It is the most common of all; doubtless, because the alum-makers use both urine and muriate of potash to crystallize their alum. Vauquelin has lately analysed a number of specimens of alum manufactured in different countries. The result was, that they all contain very nearly the same proportion of ingredients. The mean of all his trials was as follows:

Acid	30.52
Alumina	10.50
Potash	10.40
Water	48.58
	100.00

When an unusual quantity of potash is added to alum liquor, the salt loses its usual form and crystallizes in cubes. This constitutes a fourth variety of alum, usually distinguished by the name of cubic alum. It contains an excess of alkali. When the potash is still further increased, Chaptal has observed, the salt loses the property of crystallizing altogether, and falls down in flakes. This constitutes a fifth variety of alum, consisting of sulphate of potash combined with a small proportion of alumina. If three parts of alum and one of flour or sugar be melted together in an iron ladle, and the mixture dried till it becomes blackish and ceases to swell; if it be then pounded small, put into a glass phial, and placed in a sand-bath till a blue flame issues from the mouth of the phial, and after burning for a minute or two be allowed to cool, a substance is obtained known by the name of Homberg's pyrophorus, which has the property of catching fire whenever it is exposed to the open air, especially if the air be moist. This substance was accidentally discovered by Homberg about the beginning of the eighteenth century, while he was engaged in his experiments on the human fæces. He had distilled a mixture of human fæces and alum till he could obtain nothing more from it by means of heat; and four or five days after while he was taking the residuum out of the retort, he was surprised to see it take fire spontaneously. Soon after, Lemery the younger discovered that honey, sugar, flour, or almost any animal or vegetable matter, could be substituted for human fæces; and afterwards, Mr. Lejoy de Suvigny shewed that several other salts containing sulphuric acid may be substituted for alum. Scheele proved that alum deprived of potash is incapable of forming pyrophorus, and that sulphate of potash may be substituted

for alum. And Mr. Proust has shewn that a number of neutral salts, composed of vegetable acids and earths, when distilled by a strong fire in a retort, leave a residuum which takes fire spontaneously on exposure to the air. These facts have thrown a great deal of light on the nature of Homberg's pyrophorus, and enabled us in some measure to account for its spontaneous inflammation. It has been ascertained, that part of the sulphuric acid is decomposed during the formation of the pyrophorus, and of course a part of the alkaline base becomes uncombined with acid; and the charcoal, which gives it its black colour, is evidently divided into very minute particles. It has been ascertained, that during the combustion of the pyrophorus a quantity of oxygen is absorbed. The inflammation is probably occasioned by the charcoal; the sulphuret of potash also acts an essential part. Perhaps it produces a sudden increase of temperature by the absorption and solidification of water from the atmosphere.

A new process for making alum is used at some works, for which we are indebted to Mr. Sadler, which is as follows: The boilers are filled with prepared liquor of 10 pennyweights, to which sulphate of potash is added, and boiled together, until it weighs 16 pennyweights, by which time the whole of the superfluous alumina and the oxyde of iron is precipitated. The fluid is then run into a settler, where it remains until clear, after which it is pumped into a second boiler, and evaporated up to 26 pennyweights, let into the coolers, and left to crystallize. By this process, it is said, he gains the whole of the alum at one evaporation, and from the mother liquor remaining there is a product, the sulphate of iron.

ALUMINA, in chemistry, one of the five proper earths. It was discovered by the alchemists that alum was composed of sulphuric acid and an earth, the nature of which was long unknown; but Geoffroy, and afterwards Margraff, found that the earth of alum is an essential ingredient in clays, and gives them their properties, hence it was called *argil*; but Morveau gave it the name of *alumina*, because it is obtained in a state of the greatest purity from alum by the following process. Dissolve alum in water, and add to the solution ammonia as long as any precipitate is formed. Decant off the fluid part, and wash the precipitate in a large quantity of water, and then allow it to dry. The substance thus obtained is alumina; not however in a state of absolute purity, for it still retains a portion of the sulphuric acid with which it was combined in the alum. But it may be rendered tolerably pure, by dissolving the newly precipitated earth in muriatic acid, evaporating the solution till a drop of it in cooling deposits small crystals, setting it by to crystallize, separating the crystals, concentrating the liquid a second time, and separating the crystals which are again deposited. By this process, most of the alum which the earth retained will be separated in crystals. If the liquid be now mixed with ammonia as long as any precipitate appears, this precipitate, washed and dried, will be alumina nearly pure. Alumina has little taste: when pure, it has no smell; but if it contains oxyde of iron, which it often does, it emits a peculiar smell when breathed upon, known by the name of earthy smell. This smell is very perceptible in common clays. The specific gravity of alumina is 2.00. When heat is applied to alumina, it gradually loses weight, in consequence of the evaporation of a quantity of water with which, in its usual state, it is combined; at the same time its bulk is considerably diminished. The spongy alumina parts with its moisture very readily; but the gelatinous retains it very strongly. Spongy alumina, when exposed to a red heat, loses 0.58 parts of its weight; gelatinous, only 0.43: spongy alumina loses no more than 0.58 when exposed to a heat of 130° Wedgewood; gelatinous in the same temperature loses but 0.4825. Yet Saussure has shown that both species, after being dried in the temperature of 60°, contain equal proportions of water. Alumina undergoes a diminution of bulk proportional to the heat to which it is exposed. This contraction seems owing, in low temperatures, to the loss of moisture; but in high temperatures it must be owing to a more intimate combination of the earthy particles with each other; for it loses no perceptible weight in any temperature, however high, after being exposed to a heat of 130° Wedgewood.

Mr. Wedgewood took advantage of this property of alumina, and by means of it constructed an instrument for measuring high degrees of heat. It consists of pieces of clay of a determinate size, and an apparatus for measuring their bulk with accuracy: one of these pieces is put into the fire, and the temperature is estimated by the contraction of the piece. The contraction of the clay-pieces is measured by means of two brass rules, fixed upon a plate, the

distance between which at one extremity is 0.5 inch, and the other extremity 0.3 inch; and the rules are exactly 24.0 inches in length, and divided into 240 equal parts, called degrees. These degrees commence at the widest end of the scale. The first of them indicates a red heat, or 947° Fahrenheit. The clay-pieces are small cylinders, baked in a red heat, and made so as to fit 1° of the scale. They are not composed of pure alumina, but of a fine white clay. Alumina is scarcely soluble in water; but may be diffused through that liquid with great facility. Its affinity for water, however, is very considerable. In its usual state it is combined with more than its own weight of water, and we have seen with what obstinacy it retains it. Even this combination of alumina and water is capable, in its usual state of dryness, of absorbing 2½ times its weight of water, without suffering any to drop out. It retains this water more obstinately than any of the earths hitherto described. In a freezing cold it contracts more, and parts with more of its water, than any other earth; a circumstance which is of some importance in agriculture. Alumina has no effect upon vegetable blues. It cannot be crystallized artificially; but it is found native in beautiful transparent crystals, exceedingly hard, and having a specific gravity of 4. It is distinguished in this state by the name of *sapphyr*. It does not combine with metals; but it has a strong affinity for metallic oxydes, especially for those oxydes which contain a maximum of oxygen. Some of these compounds are found native. Thus, the combination of alumina and red oxyde of iron often occurs in the form of a yellow powder, which is employed as a paint, and distinguished by the name of ochre. There is a strong affinity between the fixed alkalies and alumina. When heated together, they combine, and form a loose mass, without any transparency. Liquid fixed alkali dissolves alumina by the assistance of heat, and retains it in solution. The alumina is precipitated again unaltered, by dropping an acid into the solution. This is a method employed by chemists to procure alumina in a state of complete purity; for alumina, unless it be dissolved in alkali, almost always retains a little oxyde of iron and some acid, which disguise its properties. Liquid ammonia is also capable of dissolving a very minute proportion of newly precipitated alumina. Barytes and strontian also combine with alumina, both when heated with it in a crucible, and when boiled with it in water. The result, in the first case, is a greenish or bluish-coloured mass, cohering but imperfectly: in the second, two compounds are formed; the first, containing an excess of alumina, remains in the state of an insoluble powder; the other, containing an excess of barytes or strontian, is held in solution by the water. Alumina has a strong affinity for lime, and readily enters with it into fusion. None of the earths is of more importance to mankind than alumina; it forms the basis of china and stone-ware of all kinds, and of the crucibles and pots employed in all those manufactures which require a strong heat. It is absolutely necessary to the dyer and calico-printer, and is employed too with the greatest advantage by the fuller and cleaner of cloth.

ALURNUS, in natural history, a genus of insects of the order Coleoptera. Essen. character: antennæ filiform, short: feelers four to six, very short: jaw horney, arched. There are three species—A. grossus, an inhabitant of South America and India: A. femoratus, found in India: and A. dentipes, found at the Cape of Good Hope.

ALYSSO, or ALYSSUM, *mad-wort*, in botany, a genus of the Tetradynamia Esculosa class of plants; the flower is of the cruciform kind, and consists of four leaves: the fruit is a small roundish capsule, divided into two cells, in which are contained a number of small roundish seeds.

The alyssum is arranged in three divisions, viz. into A. in which the stem is somewhat shrubby: B. stems herbaceous: C. silules inflated, or calyx oblong, closed. There are 33 species; but according to Martyn only 17. All the species may be propagated by seed, and most of them by slips and cuttings. In rich ground they seldom live through the winter in England; but in dry, poor, rubbishy soil, or on old walls, they will abide the cold, and last much longer.

AMALGAM, in the arts. The metals in general unite very readily with one another, and form compounds; thus pewter is a compound of lead and tin, brass is a compound of copper and zinc, &c. These are all called alloys, except when one of the combining metals is mercury; in that case the compound is called an *amalgam:* thus mercury and gold form a compound called the amalgam of gold.

The amalgam of gold is formed very readily, because there is a very strong affinity between the two metals. If a bit of gold be dipped into mercury, its surface, by combining with mercury, becomes as white as silver. The easiest way of forming this

amalgam is to throw small pieces of red hot gold into mercury heated till it begins to smoke. The proportions of the ingredients are not determinable, because they combine in any proportion. This amalgam is of a silvery whiteness. By squeezing it through leather, the excess of mercury may be separated, and a soft white amalgam obtained, which gradually becomes solid, and consists of about one part of mercury to two of gold. It melts at a moderate temperature; and in a heat below redness the mercury evaporates, and leaves the gold in a state of purity. It is much used in gilding. The amalgam is spread upon the metal which is to be gilt; and then, by the application of a gentle and equal heat, the mercury is driven off, and the gold left adhering to the metallic surface: this surface is then rubbed with a brass wire brush under water, and afterwards burnished. The amalgam of silver is made in the same manner as that of gold, and with equal ease. It forms dentritical crystals, which contain eight parts of mercury and one of silver. It is of a white colour, and is always of a soft consistence. Its specific gravity is greater than the mean of the two metals. Gillert has even remarked, that when thrown into pure mercury, it sinks to the bottom of that liquid. When heated sufficiently, the mercury is volatilized, and the silver remains behind pure. This amalgam is sometimes employed, like that of gold, to cover the surfaces of the inferior metals with a thin coat of silver. The amalgam of tin and mercury is much used in electricity. See GILDING.

AMARANTHUS, in botany, a genus of the Monoecia Pentandria class and order, of the Triandria Trigynia of Gmelin's Linnæus; its characters are, that those species which have male flowers on the same plants with the females have a calyx, which is a five or three-leaved perianthium, upright, coloured, and permanent; the leaflets lanceolate and acute; no corolla; the stamina have five or three capillary filaments, from upright patulous, of the length of the calyx, the anthers oblong and versatile: of those which have female flowers in the same raceme with the males, the calyx is a perianthium the same with the former; no corolla; the pistillum has an ovate germ, styles three, short and subulate; stigmas simple and permanent; the pericarpium is an ovate capsule, somewhat compressed, as is also the calyx on which it is placed, coloured, and of the same size, three-beaked, one-celled, cut open transversely; the seed is single, globular, compressed, and large. There are 22 species, of which we notice A. melancholicus, two-coloured A. with glomerules, axillary, peduncled, roundish, and leaves ovate-lanceolate, and coloured. This species varies in the colour of the leaves; being in the open air of a dingy purple on their upper surface, and the younger ones green; in a stove the whole plant is purple-coloured; but it is easily distinguished in all states by its colour, leaves, and the lateness of its flowering after all the others are past: it is joined by La Marck with A. tricolor; a native of Guiana and the East Indies, and cultivated in 1731 by Miller. The obscure purple and bright crimson of the leaves are so blended as to set off each other, and, in the vigorous state of the plants, to make a fine appearance. A. tricolor, three-coloured A. with glomerules sessile, roundish; stem clasping, and leaves lanceolate-ovate, coloured. This has been long cultivated, being in the garden of Gerard in 1596, for the beauty of its variegated leaves, in which the colours are elegantly mixed; these, when the plants are vigorous, are large and closely set from the bottom to the top of the stalks, and the branches form a kind of pyramid, and therefore there is not a more handsome plant when in full lustre: a native of Guiana, Persia, Ceylon, China, Japan, the Society Isles, &c. A. lividus, livid A. These are the most worthy of a place in the pleasure-garden; but they are tender, and require attention. They are usually disposed in pots, with cocks-combs and other showy plants, for adorning court-yards, and the environs of the house. The seeds of these should be sown in a moderate hot-bed, about the end of March; and when the plants come up, they should have much air in mild weather. When they are fit for transplanting, they should be removed to another moderate hot-bed, and placed at six inches distance, watering and shading them till they have taken new root; afterwards they should have free air, and frequent but gentle waterings. In the beginning of June they should be taken up, with large balls of earth to their roots, and planted either in pots or the borders of the pleasure-garden, shaded till they have taken root, and afterwards frequently watered in dry weather. The tree amaranth must be planted in a rich light soil, and if it be allowed room, and well watered in dry weather, it will grow to a large size, and make a fine appearance. The other sorts are sufficiently hardy to bear the open air, and may be sown on a bed of

light earth, in the spring, and when the plants are fit to remove, transplanted into any part of the garden, where they will thrive, and produce plenty of seeds.

AMARILLIS, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Liliæ or Liliaceæ; its characters are, that the calyx is a spathe, oblong, obtuse, compressed, emarginate, gaping on the flat side, and withering; the corolla has six petals, lanceolate, the nectary has six very short scales without the base of the filaments; the stamina have six awl-shaped filaments, with oblong, incumbent, rising anthers; the pistillum has a roundish, furrowed, inferior germ, the style filiform, almost of the length and in the situation of the stamens, the stigma trifid and slender; the pericarpium is a subovate, three-celled, three-valved capsule; and the seeds are several. The inflection of the petals, stamens, and pistil is very various in the different species of this genus; and the corolla in most of the species is rather hexapetaloid than six-petalled. Gmelin reckons 27 species. A. lutea, yellow A. or autumnal narcissus, with an undivided obtuse spathe, sessile; flower bell-shaped; corolla erect, shortly tubular at the base, and erect stamens, alternately shorter; the flowers seldom rise above three or four inches high; the green leaves come up at the same time, and when the flowers are past, the leaves increase through the winter. This species recedes a little from the genus. It is a native of the south of France, Spain, Italy, and Thrace; was cultivated by Gerard in 1596, and flowers in September. A. formosissima, jacobea lily, so called, because some imagined that they discovered in it a likeness to the badge of the order of the knights of the order of St. James, in Spain, the lilionarcissus and narcissus of others, with a spathe undivided, flower pedicelled, corolla two-lipped, nodding, deeply six-parted stamens, and pistil bent down. The flowers are produced from the sides of the bulbs, are large, of a deep red, and make a beautiful appearance: it is a native of America, first known in Europe in 1593, some roots of it having been found on board a ship which had returned from South America, by Simon de Jovar, a physician at Seville, who sent a description of the flowers to Clusius, who published a drawing of it in 1601, called by Parkinson, who figured it in 1629, the Indian daffodil, with a red flower: cultivated in the Oxford Garden in 1658. A. reginæ, Mexican lily, with spathe, having about two flowers, pedicels divaricating, corollas bell-shaped, shortly tubular, nodding, throat of the tube hirsute, and leaves lanceolate, patulous; the bulb is green, corolla scarlet, and at the bottom whitish green, the style red, the flowers large, of a bright copper colour, inclining to red: it flowered in Fairchild's garden, at Hoxton, in 1728; and Dr. Douglas wrote a folio pamphlet upon it, giving it the title of lilium reginæ, because it was in full beauty on the first of March, the queen's birth-day: the roots were brought from Mexico, and therefore Mr. Fairchild called it Mexican lily, the name which it has retained. It flowers in the spring in a very warm stove; is in beauty in February; and in a moderate temperature of air will flower in March or April. A. sarniensis, lilium sarniense of Douglas, who published a description of it in 1725; narcissus of others; Guernsey lily, so called by Mr. Ray in 1665; with petals linear, flat, stamens and pistil straightish, longer than the corolla, stigmas, parted and revolute. The bulb is an oblong spheroid; the leaves are dark willow green; the number of flowers is commonly from eight to twelve, and circumference of each about seven inches; the corolla, in its prime, has the colour of a fine gold tissue, wrought on a rose-coloured ground, and when it begins to fade, it is a pink; in full sunshine, it seems to be studded with diamonds, but by candle-light the specks or spangles appear more like fine gold dust; when the petals begin to wither, they assume a deep crimson colour. The flowers begin to come out at the end of August, and the head is usually three weeks in gradually expanding. This beautiful plant is a native of Japan, and has been long naturalized in Guernsey. It is said to have been brought from Japan to Paris, and cultivated in Morin's garden before 1634. It was cultivated at Wimbledon, in England, by General Lambert, in 1659, and in 1664 became more common: it does not seem to have been in Holland before 1695. The plants are reputed to owe their origin in Guernsey to the shipwreck of a vessel returning from Japan, probably before the middle of the seventeenth century. The bulbs, it is said, being cast on shore, took root in that sandy soil, and produced beautiful flowers, which engaged the attention of Mr. Hatton, the governor's son, who sent roots to several of his friends. A variety of this found at the Cape of Good Hope is des-

cribed by Jacquin, with a many-flowered spathe, corollas very patent and reflex at the apex, stamens and pistil somewhat straight, longer than the corolla, and leaves ensiform-linear. Most of these species have very beautiful flowers, and merit the attention of the botanist and florist. The first, or yellow autumnal A. is very hardy, and increases by offsets. The season for transplanting these roots is from May to the end of July, when the leaves are decayed. They will grow in any soil or situation; but they will thrive best in a fresh, light, dry soil, and open situation, and will keep flowering from the beginning of September to the middle of November, provided that they escape severe frosts; and a succession of flowers will spring from the same root. The Guernsey lily has been cultivated for many years in the gardens of Guernsey and Jersey, whence the roots are sent to most parts of Europe. The bulbs are commonly brought over in June and July, and they should then be planted in pots filled with fresh, light, sandy earth, mixed with a small quantity of very rotten dung, placed in a warm situation, and occasionally refreshed with water. About the middle of September the stronger roots will shew their red-coloured flower-stem; and then the pots should be removed into a situation where they may have the full benefit of the sun, and be sheltered from strong winds; but not placed under glasses, or too near a wall, which would draw them up, and render them less beautiful. When the flowers begin to open, the pots should be put under shelter, so as to be secure from too much wet, but not kept too close or too warm. The flowers will continue in beauty for a month; and though without scent, their rich colour entitles them to the first rank in the flowery tribe.

AMASONIA, in botany, a genus of the Didynamia Angiospermia class and order: calyx five-cleft: corolla tubular, with a small five-cleft border: berry four-seeded. There are two species.

AMATEUR, in the arts, denotes a person understanding, loving, or practising the fine arts, without any regard to pecuniary advantage.

AMBASSADOR, a person appointed by one sovereign power to another, to superintend his affairs at some foreign court, and supposed to represent the power from which he is sent. The person of an ambassador is inviolable.

AMBER, in mineralogy, a resinous substance, called by the ancients electrum, found in different countries; but most abundantly in Prussia, either on the sea-shore, or under ground at the depth of 100 feet, reposing on wood coal. It is obtained in lumps of different sizes. There are the white and the yellow amber. 1. The white amber is in colour straw-yellow inclining to yellowish white; but, 2. The yellow amber is a wax-yellow passing to a honey-yellow, yellowish brown, and hyacinth-red. It is found in blunt pieces with a rough surface. It is rather brittle, and its specific gravity is from 1.07 to 1.08. Amber burns with a yellow-coloured flame, and if the heat be strong enough, melts and emits a peculiar agreeable odour, and leaves little ashes. When rubbed, it acquires a strong negative electrical virtue. From this property is derived the word electricity. It is composed of carbon, hydrogen, and oxygen. According to Sir J. Hill, it is said that amber has been found in digging into the alluvial land in the vicinity of London. It is found sometimes on the sea-shores of several parts of England. Being susceptible of a fine polish, it is cut into necklaces, bracelets, snuff-boxes, and other articles of dress. Before the discovery of the diamond and other precious stones of India, it was considered to be the most precious of jewels, and was employed in all kinds of ornamental dress: altars were likewise ornamented with it. The greatest quantity at present consumed in commerce, it purchased by Armenian and Grecian merchants, for the use, it is conjectured, of pilgrims, previously to their journey to Mecca, and that on their arrival there, it is burnt in honour of the prophet Mahomet. The acid and oil obtained from it are used as medicines.

It often contains insects of various species, in a state of complete preservation, also leaves, and other parts of vegetables. Various conjectures have been made respecting its origin and formation. By some it is, as we have already seen, considered as a vegetable gum or resin; others regard it as a mineral oil, thickened by the absorption of oxygen; and Mr. Parkinson is of opinion, that it is inspissated mineral oil. There was lately found in Prussia a mass of amber which weighed upwards of 13 pounds, the contents of which amounted to $318\frac{3}{4}$ cubic inches. Five thousand dollars are said to have been offered for it; and the Armenian merchants assert that in Constantinople it would sell for six times that price at

least. Pitch-coal is sometimes found with amber, and is called *black*, and is sold to the ignorant at a great price. Specimens inclosing insects, &c. are highly valued, and the amber-dealers are said to be possessed of means of softening it, in order to introduce insects and other foreign bodies into it. Two parts of the empyreumatic oil obtained by distilling mineral pitch boiled several times, with three parts of turpentine, form a compound, which bears a great resemblance to amber, and which is often cut into necklaces and other ornaments, and sold as true amber.

AMBERGRIS, in chemistry, is a substance found floating on the sea, near the coasts of India, Africa, and Brazil, usually in small pieces, but sometimes in masses of 50 or 100 pounds in weight. Various opinions have been entertained concerning its origin. Some affirmed that it was the concrete juice of a tree; others thought it a bitumen; but it is now established, that it is a concretion formed in the stomach or intestines of the physeter macrocephalus, or spermaceti whale. Ambergris, when pure, is a light soft substance which swims on water. Its specific gravity varies from 0.78 to 0.844. Its colour is ash-grey, with brownish yellow and white streaks. It has an agreeable smell, which improves by keeping. Its taste is insipid. When heated to 122° it melts without frothing; if the heat be increased to 212°, it is volatilized completely in a white smoke, leaving only a trace of charcoal. When distilled, we obtain a whitish acid liquid and a light volatile oil; a bulky charcoal remains behind. It is insoluble in water. Acids have little action on it. Weak sulphuric acid occasions no change; but when concentrated, it developes a little charcoal. Nitric acid dissolves it, giving out at the same time nitrous gas, carbonic acid, and azotic gas. A brownish liquid is formed, which leaves, when evaporated to dryness, a brittle brown substance, possessing the properties of a resin. The alkalies dissolve it by the assistance of heat, and form a soap soluble in water. Both the fixed and volatile oils dissolve ambergris. It is soluble also in ether and alcohol. It possesses the properties of the salty matter into which the muscles are converted by nitric acid, and which makes its appearance when dead bodies are allowed to putrefy in great numbers together. This substance has been distinguished by the name of adipocire, from its resemblance both to fat and wax. The quantity of it in ambergris amounts to 52.8 parts. According to the analysis of ambergris made by Bouillon La Grange, it is composed of

52.7	adipocire
30.8	resin
11.1	benzoic acid
5.4	charcoal
100.0	

AMBIDEXTER, a person who can use both hands with the same facility, and for the same purposes, that the generality of people do their right hands.

Were it not for education, some think that all mankind would be ambidexters; and, in fact, we frequently find nurses obliged to be at a good deal of pains before they can bring children to forego the use of their left hands. It is to be regretted, that any of the gifts of nature should be thus rendered in a great measure useless, as there are many occasions in life which require the equal use of both hands: such are the operations of bleeding in the left arm, left ancle, &c.

AMBROSIA, in botany, the name of a distinct genus of plants, with flosculous flowers, composed of several small infundibuliform floscules, divided into five segments: these, however, are barren; the fruit, which in some measure resembles a club, growing on other parts of the plant.

This genus belongs to the Monoecia Pentandria class and order. There are five species.

AMBROSINIA, in botany, a genus of the Monoecia Monadelphia class and order; of which there is a species, found in the island of Sicily: spathe one-leafed, separated by a membranaceous partition, containing the stamina in the hinder cell and upper part of the partition, pistils in the outer cell, and lower part of the partition: the root is tuberous; leaves radical, ovate, and shining.

AMBUSCADE, or AMBUSH, in the military art, properly denotes a place where soldiers may lie concealed, till they find an opportunity to surprise the enemy.

AMELLUS, in botany, a genus of the Syngenesia Superflua: receptacle chaffy: down simple: calyx imbricate: florets of the ray undivided. There are three species.

AMELIORALING *crops*, in husbandry, are such as are supposed to improve the lands on which they are cultivated. Most of those plants which have a large stem and shady leaf, are thought to render the

soils on which they grow, more fertile, by producing a confined or stagnant state of the air. The improvement of lands by what are called ameliorating crops, probably depends upon the culture which the ground receives while they are growing, and the returns which they make to it in the way of manure, after they are consumed by animals.

AMEN, in the scripture language, a solemn formula, or conclusion to all prayer, signifying *so be it.*

The term *amen* is Hebrew, being derived from the verb *aman, i. e.* to be true, faithful, *&c.* so that, strictly speaking, it signifies truth; and, used adverbially, as is frequently done in the gospels, truly or verily. Sometimes it is repeated twice together, and then it stands for the superlative, as *amen, amen, dico vobis.*

The word, in music, forms the usual conclusion of anthems, hymns, and other sacred compositions; and has so long been one of the principal themes of choral harmony, as to have given birth to a distinct appellation for music adapted to its expression: as when, using the word adjectively, we say, such an oratorio or anthem concludes with an *Amen* chorus.

AMEND, or AMENDE, in the French customs, a pecuniary punishment imposed by a judge for any crime, false prosecution, or groundless appeal.

AMENDE *honorable,* an infamous kind of punishment inflicted in France upon traitors, parricides, or sacrilegious persons, in the following manner: the offender being delivered into the hands of the hangman, his shirt is stripped off, and a rope put about his neck, and a taper in his hand; then he is led into court, where he must beg pardon of God, the King, the Court, and his Country. Sometimes the punishment ends here, but sometimes it is only a prelude to death, or banishment to the gallies.

Amende honorable is a term also used for making recantation in open court, or in presence of the person injured.

AMENDMENT, in law, the correction of an error committed in a process, which may be amended after judgment, unless the error lies iu giving judgment, for in that case it is not amendable, but the party must bring a writ of error.

A bill may be amended on the file at any time before the plea is pleaded; but not afterwards, without motion and leave of the court.

AMERCEMENT, or AMERCIAMENT, in law, a pecuniary punishment imposed upon offenders at the mercy of the court. Amercements differ from fines, the latter being certain punishments growing expressly from some statute, whereas the former are imposed arbitrarily in proportion to the fault.

Besides, fines are assessed by the court, but amercements by the country.

A court of record only can fine, all others can only amerce.

Sheriffs are amerciable for the faults of their officers, and clerks of the peace may be amerced in the King's-bench for gross faults in indictments removed to that court.

A town is subject to amercement for the escape of a murderer in the day-time, and if the town is walled, it is subject to amercement whether the escape happens by day or night.

The statute of Magna Charta ordains, that a freeman is not to be amerced for a small fault, but in proportion to the offence, by his peers and equals.

AMERIMNUM, or AMERIMNON, in botany, a genus of the Diadelphia Decandria class and order, of the natural order of Papilionaceæ or Leguminosæ; the characters of which are, that the calyx is a one-leafed perianthium; tube bell shaped, five-toothed, the teeth sharp; the corolla papillionaceous, standard with an oblong claw, roundish, heart-shaped, expanding and convex, wings lanceolate, shorter than the standard, and keel short; the stamina have 10 filaments conjoined, anthers roundish; the pistillum has a gum pedicelled, oblong, compressed, leafy, varicose, with lateral veins, within woody, not gaping; cells disposed longitudinally within; the seeds solitary, kidney-shaped, thicker at the base, appendicted at the top. There are two species, viz 1. A. Brownei: this shrub rises commonly to the height of ten feet, and supports itself on other shrubs. It is a native of Carthagena, Jamaica, and Domingo. 2. A. ebenus, Jamaica ebony, which is common in Jamaica and several other parts of the West Indies, where the wood is cut, and sent into England under the name of ebony, though the true ebony is a native of the eastern country, and of a different genus. This wood is of a fine greenish brown colour, admits of polishing well, so that it is much valued by the instrument makers, and it is of a very hard durable nature. Dr. Browne says, that the trunk seldom exceeds three or four inches in diameter; that the slender branches, being very tough and flexible, are used for riding switches, and kept

at all the wharfs about Kingston to scourge the refractory slaves.

AMETHYST, in mineralogy, is one of the Quartz family; it occurs massive and in rolled pieces, but most frequently crystallized. The crystals are six-sided pyramids: colour violet blue, passing on the one hand to plum blue, brown, brownish black; on the other to pearl and ash grey, greyish white, greenish white, olive green, and in some rare cases pistachio green. In massive varieties several colours appear together in stripes: in this state they are composed of thick prismatic distinct concretions, often shooting into crystals at their extremities. Specific gravity 2.75. It is found in veins, and in the hollow cavities of agates. It is composed of

Seleca	97.50
Alumina	0.25
Oxyd of iron	0.50
and a	
Trace of mangenese	——
	98.25

It is found abundantly in different parts of Saxony: also in the Hartz, in the Uralian mountains, and in the East Indies. The most beautiful varieties are found at Catharinaburg in Russia. It is cut into rings, seals, and boxes, but it is not very highly valued. The green is the chrysolite of some authors: the oriental amethyst is the sapphire: it is sometimes covered with capillary crystals of iron mica, and when viewed in certain positions appears red; this variety is named the hair amethyst.

AMETHYST, in heraldry, a term for the purple colour in the coat of a nobleman, in use with those who blazon by precious stones instead of metals and colours. This in a gentleman's escutcheon is called purpure, and in those of sovereign princes mercury.

AMETHYSTEA, *amethyst*, so called from the amethystine colours of the flowers, in botany, a genus of the Diandria Monogynia class, the characters are, that the calyx is a perianthium one-leafed, tube bell-shaped, angular, semiquinquefid, subequal, acuminate, and permanent; the corolla is one-petalled, ringent, little longer than the calyx; border five-parted and subequal; upper lip erect, roundish, concave, two-parted, gaping; lower three-parted; the sides rounded, erect, shorter; the middle quite entire, concave, the length of the upper-lip; the stamina have filaments, filiform, approximating, under the upper lip and longer than it; anthers simple and roundish; the pistillum is a quadrifid germ, style size of the stamens, stigmas two and acute; no pericarpium, but the calyx becomes more bell-shaped and spreading; the seeds are four, shorter than the calyx; obtuse, and angular within. There is one species, viz. A. cœrulia, mountain upright A. which is a native of the mountains in Siberia, from whence the seeds were sent to the Imperial garden at Petersburgh, and in 1759 to Chelsea garden, where the plants annually produce seeds. It is annual, and hath an upright stalk, which rises about a foot high, and towards the top puts out two or three small lateral branches; these are garnished with small trifid leaves, sawed on their edges, and of a very dark green colour; at the extremity of the branches the flowers are produced in small umbels; these are of a fine blue colour, as are also the upper part of the branches, and the leaves immediately under the umbel; so that though the flowers are small, yet from their colour with that of the upper part of the stalks, the plants make a pretty appearance during their continuance in flower.

AMIA, in natural history, a genus of fishes of the order Abdominales. Generic character: head boney, naked, rough, with visible sutures. Teeth both in jaws and palate, close set, sharp, numerous. Cirri or beards two, near the nostrils. Gill-membrane twelve-rayed: body scaly. There is a single species, a small fresh water fish inhabiting some parts of Carolina.

AMIABLE, or *amicable numbers*, such as are mutually equal to the sum of one another's aliquot parts, as the numbers 284 and 220.

Van Schouten was the first who gave this name to such numbers, of which there are but very few at least to be set down and manageable by us. For 284 and 220 are the two least. The aliquot parts of 220 are 1, 2, 4, 5, 10, 11, 20, 22, 44, 55, 110, and the sum of these is equal 284. The aliquot parts of 284 are 1, 2, 4, 71, 142, and the sum of these is 220. The second pair of amicable numbers are 17296 and 18416. The third pair are 9363584 and 9437056.

AMIANTHUS. S.ee ASBESTOS.

AMICUS *curiæ*, in law, if a judge be doubtful or mistaken, in a matter of law, a bystander may inform the court as *amicus curiæ*.

AMMANNIA, named by Houstoun in honour of J. Amman, in botany, a genus of the Tetrandria Monogynia class and order. Its characters are, that the calyx is a pe-

rianthium bell-shaped, oblong, erect, with eight streaks and folds, quadrangular, eight-toothed, teeth alternate, bent in, and permanent; corolla none, or four-petalled, petals vertically ovate, spreading, inserted into the calyx; the stamina have filaments, (four or eight) bristly, the length of the calyx into which they are inserted, anthers twin; the pistillum is a germ subovate, large and superior, style simple, very short, and stigma headed; the pericarpium is a roundish, four-celled capsule (bury) covered with the calyx; the seeds are numerous and small.

AMMI, *bishop's weed*, in botany, a distinct genus of umbelliferous plants, belonging to the Pentandria Digynia class of Linnæus; the flower of which is rosaceous, and composed of heart-like petals; and its fruit is a small roundish and striated capsule, containing two striated seeds, convex on one side, and plane on the other. There are four species.

AMMODYTES, in natural history, the *launce*, a genus of fishes, of the order Apodes: head compressed, narrower than the body: upper-lip doubled: lower jaw narrow, pointed: teeth small and sharp. Gill membrane seven rayed: body long, roundish, with very small scales: tail distinct. A. tobianus, or sand launce, so named from its shape. It inhabits the northern seas; and is from 9 to 12 inches long. It buries itself on the recess of the tides a foot deep in the sand, and in fine weather rolls itself up and lifts its nose just above the sand; it is the prey of other rapacious fish; the flesh is tolerably good, but it is used in most cases as baits. The launce lives on worms, water-insects, and small fishes, and even occasionally on those of its own species. The mackarel is very partial to this fish as its own food. The launce spawns in May, depositing its eggs in the mud, near the edges of the coast.

AMMONIA, in chemistry. Volatile alkali, in its purest form, subsists in a state of gas, and was thought, till the late experiments of Mr. Davy, to be composed of azote and hydrogen. It may be obtained in the following manner: put into a retort a mixture of three parts of quick-lime and one part of sal ammoniac in powder. Plunge the beak of the retort below the mouth of a glass jar filled with mercury, and standing inverted in a bason of mercury. Apply the heat of a lamp to the retort: a gas comes over, which displaces the mercury and fills the jar. This gas is ammonia. It was known by the name of volatile alkali; it was also called hartshorn, because it was often obtained by distilling the horn of the hart; spirit of urine, because it may be obtained by the same process from urine; and spirit of sal ammoniac, because it may be obtained from that salt. Dr. Black first pointed out the difference between ammonia and carbonate of ammonia, or ammonia combined with carbonic acid; and Dr. Priestley discovered the method of obtaining it in a state of purity, by the process already described. Ammonia in the state of gas it transparent and colourless like air; its taste is acrid and caustic like that of the fixed alkalies, but not nearly so strong, nor does it like them corrode those animal bodies to which it is applied: its smell is remarkably pungent, though not unpleasant when sufficiently diluted. Its use as a stimulant to prevent fainting is well known. Animals cannot breathe it without death. When a lighted candle is let down into this gas, it goes out three or four times successively; but at each time the flame is considerably enlarged by the addition of another flame of a pale yellow colour, and at last this flame descends from the top of the vessel to the bottom. Its specific gravity, according to the experiments of Kirwan, is 0.60, that of air being 1.00; while Mr. Davy, whose gas was probably purer, found it 0.55. At the temperature of 60°, a hundred cubic inches of this gas weigh, according to Kirwan, 18.16 grains, according to Davy, 17.068. Hence it is to common air, nearly as 3 to 5. When exposed to a cold of — 45° it is condensed into a liquid, which again assumes the gaseous form when the temperature is raised. When passed through a red hot tube of porcelain or glass, it is totally decomposed and converted into hydrogen and azotic gas. It combines very rapidly with water. When a bit of ice is brought into contact with this gas, it melts and absorbs the ammonia, while at the same time its temperature is diminished. Cold water absorbs this gas almost instantaneously, and at the same time heat is evolved, and the specific gravity of the water is diminished. Water is capable of absorbing and condensing more than a third of its weight of ammoniacal gas. It is in this state that ammonia is usually employed by chemists. The term ammonia almost always means this liquid solution of ammonia in water. When heated to the temperature of about 130°, the ammonia separates under the form of gas. When exposed

to the temperature of — 46° it crystallizes; and when suddenly cooled down to — 68°, it assumes the appearance of a thick jelly, and has scarcely any smell. It follows from the experiments of Mr. Davy, that a saturated solution of ammonia is composed of

74.63 water.
25.37 ammonia.

100.00

Charcoal absorbs ammoniacal gas, but does not alter its properties while cold. But when the gas is made to pass through red hot charcoal, part of the charcoal combines with it, and forms a substance known by the name of prussic acid. Ammonia is not acted on by azote; but it combines rapidly with muriatic acid; the two gases concreting into the solid salt called muriate of ammonia. Ammonia does not combine with the metals; but it changes some of them into oxydes, and then dissolves them. Liquid ammonia is capable of dissolving the oxydes of silver, copper, iron, tin, nickel, zinc, bismuth, and cobalt. When digested upon the oxydes of mercury, lead, or manganese, it is decomposed, water is formed by the union of the hydrogen of the ammonia with the oxygen of the oxides, and azotic gas is omitted. If a considerable heat be applied, nitric acid is formed at the same time with water. Several other oxydes are also partly deoxidized when ammonia is poured into their solutions in acids. See Alkali, Chemistry, &c.

AMMONIAC, in chemistry, a gum resin brought from the East Indies. It is supposed to be a species of the Ferula. It is in small pieces agglutinated together, and has a yellowish white colour. Its smell is like that of the galbanum, but more pleasant. Its taste is a nauceous sweet mixed with bitter. It does not melt. Water dissolves a portion of it; the solution is milky, but gradually lets fall a resinous portion. One-half is soluble in alcohol. Its specific gravity is 1.2. Neither alcohol nor water distilled off it, brings over any thing.

AMMONITRUM. See Glass.

AMMOPHILA, in natural history, the *sand-wasp*, a genus of insects of the order Hymenoptera: gen. char. snout conic, inflected, concealing a bifid retractile tubular tongue: jaws forcipated, three toothed at the tip: antennæ filiform in each sex, with about 14 articulations: eyes oval: wings plain: sting pungent, concealed in the abdomen. This genus is separated from that of the sphex, on the authority of the Rev. Mr. Kirby: in their manners and economy, they resemble each other; and it is probable that many more of the spheges might, with propriety, be removed into this genus. There are four species: A. vulgaris, inhabits Europe in sandy, sunny banks, where it digs a hole with its fore-feet and buries the carcase of the larva of a moth or half dead spider, in the body of which it has deposited its eggs, and then covers up the orifice.

AMMUNITION, a general term for all warlike provisions, but more especially powder, ball, &c.

Ammunition, arms, utensils of war, gunpowder, imported without licence from his Majesty, are, by the laws of England, forfeited and triple the value.

And again, such licence obtained, except for furnishing his Majesty's public stores, is to be void, and the offender to incur a præmunire, and be disabled to hold any office from the crown.

AMNESTY, in matters of policy, an act by which two parties at variance, promise to pardon and bury in oblivion all that is past.

Amnesty is either general and unlimited, or particular and restrained, though most commonly universal, without condition or exceptions; such as that which passed in Germany at the peace of Osnaburg in the year 1648.

Amnesty, in a more limited sense, denotes a pardon granted by a Prince to his rebellious subjects, usually with some exceptions: such was that granted by Charles II. at his restoration.

AMNIOS, in anatomy, a thin pellucid membrane, which surrounds the fœtus.

The fœtus in the uterus is enveloped in a peculiar membranous covering, to which anatomists have given the name of amnios. Within this there is a liquid, distinguished by the name of the liquor of the amnios which surrounds the fœtus on every part. This liquid, as might have been expected, is very different in different animals; at least the liquor amnii in women and in cows, which alone have hitherto been analysed, have not the smallest resemblance to each other. The liquor of the amnios of women is a fluid of a slightly milky colour, a weak pleasant odour, and a saltish taste. The white colour is owing to a curdy matter suspended in it, for it may be obtained quite transparent by filtration. Its specific gravity is 1.005. It gives a green colour to the tincture of violets, and yet it reddens

very decidedly the tincture of turnsole. These two properties would indicate at once the presence of an acid and of an alkali. It froths considerably when agitated. On the application of heat it becomes opaque, and has then a great resemblance to milk diluted with a large quantity of water. At the same time it exhales the odour of boiled white of egg. Acids render it more transparent. Alkalies precipitate an animal matter in small flakes. Alcohol likewise produces a flaky precipitate, which, when collected and dried, becomes transparent and very like glue. The infusion of nut galls produces a very copious brown coloured precipitate. Nitrate of silver occasious a white precipitate, which is insoluble in nitric acid, and consequently is muriate of silver. The liquor of the amnios of the cow has a viscidity similar to mucilage of gum arabic, a brownish red colour, an acid and bitter taste, and a peculiar odour, not unlike that of some vegetable extracts. Its specific gravity is 1.028. It reddens the sincture of turnsole, and therefore contains an acid. Muriate of barytes causes a very abundant precipitate, which renders it probable that it contains sulphuric acid. Alcohol separates from it a great quantity of a reddish coloured matter. The animal matter possesses the following properties: It has a reddish brown colour and a peculiar taste; it is very soluble in water, but insoluble in alcohol, which has the property of separating it from water. When exposed to a strong heat, it swells, exhales first the odour of burning gum, then of empyreumatic oil and of ammonia, and at last the peculiar odour of prussic acid becomes very conspicuous. It differs from gelatine in the viscidity which it communicates to water, in not forming a jelly when concentrated, and in not being precipitated by tannin. It must be therefore ranked among the very undefined and inaccurate class of animal mucilages. When burnt it leaves a large portion of coal, which is readily incinerated, and leaves a little white ashes, composed of phosphate of magnesia, and a small proportion of phosphate of lime.

AMOMUM, in botany, a genus of the Monandria Monogynia class and order, the characters of which are, that the calyx is a perianthium, one-leafed, cylindraceous, and unequally trifid; the corolla is monopetalous and funnel-shaped, tube cylindraceous, border three-parted, parts oblong and spreading; the nectary two-leaved or two-lipped, lower lip inserted under the upper segment of the corolla, spreading almost erect, entire or three-lobed; the stamina have no filament, except the upper lip of the nectary, smaller than the lower, and opposite to it, accuminate or three-lobed at the tip; along the middle or at the end of which grows longitudinally a large oblong anther, germinate, or divided by a longitudinal furrow into two, which are one-valved; the pistillum has an inferior, oblong germ, style filiform, drawn through the suture of the anther, stigma turbinate, obtuse and ciliate; the pericarpium a fleshy capsule, ovate, three-cornered, three-celled, and three-valved; the seeds are several, covered with a sort of berried aril. Gmelin, in his edition of Linnæus, enumerates twenty species. A. zinziber, narrow-leaved ginger, cultivated by Miller, and flowering in September, is a native of the East Indies, and other countries of Asia, and is much used there and in the West Indies. The dried roots furnish a considerable article of commerce from our West India islands; they are of great use in the kitchen and in medicine, and when preserved green as a sweet-meat, are preferable to every other sort. A. zerumbet, cultivated at Hampton-court, in 1690, and flowering with us from September to November, when the stalks perish like those of the true ginger; a native of the East Indies, Cochinchina, &c. and also in Otaheite, and the other Society Isles. This is used externally in the East, in cataplasms and fomentations; but not internally, as spice or medicine; though Garcias says, that it makes a better preserve with sugar than the other. As to the propagation and culture of these plants, it may be observed that they are tender, and require a warm stove to preserve them in this country. They are easily propagated by parting their roots, which should be done in the spring, before they put out new shoots. In parting the roots, they must not be divided into small pieces, especially if they are designed to have flowers; nor should they be planted in very large pots. They thrive best in a light rich earth, such as that of the kitchen garden; and with this the pots should be filled within two inches of the top, and the roots should be placed in the middle of the pots, with their crowns upwards, and the pots should then be filled with the same earth; they should be plunged into a hot-bed of tanner's bark, and sparingly watered, till their stalks appear above ground, when they will admit of more moisture, especially in the summer months; but in autumn, the

waterings must not be frequent nor plentiful, and during winter, very sparing. The pots must constantly remain plunged in the tan-bed; for if they are taken out and placed on shelves in the stove, their fibres often shrink, and thus their roots decay. By this management these plants have greatly multiplied, and the common ginger has produced roots, weighing five or six ounces; but the others have been nearly a pound weight. In the West Indies the ginger thrives best in a rich cool soil; in a more clayey soil the root shrinks less in scalding. The land laid out for the culture of it is first well cleared and hoed, and then slightly trenched, and planted in March or April; it flowers about September; and when the stalks are wholly withered, the roots are fit to be taken up, which is generally done in January and February.

AMONTONS (William), in biography, an ingenious French experimental philosopher, was born in Normandy the 31st of August 1663. While at the grammar school, he by sickness contracted a deafness that almost excluded him from the conversation of mankind. In this situation he applied himself to the study of geometry and mechanics; with which he was so delighted, that it is said he refused to try any remedy for his disorder, either because he deemed it incurable, or because it increased his attention to his studies. Among other objects of his study, were the arts of drawing, of land-surveying, and of building; and shortly after he acquired some knowledge of those more sublime laws, by which the universe is regulated. He studied with great care the natue of barometers and thermometers; and wrote his treatise of "Observations and Experiments concerning a new Hourglass, and concerning Barometers, Thermometers, and Hygroscopes;" as also some pieces in the Journal des Savans. In 1687, he presented a new hygroscope to the Academy of Sciences, which was much approved. He found out a method of conveying intelligence to a great distance in a short space of time: this was by making signals from one person to another, placed at as great distances from each other, as they could see the signals by means of telescopes: this was unquestionably done upon the principal of modern telegraphs, which were brought into general use in 1794, almost a century after the death of Amontons. Amontons was chosen a member of the Royal Academy in 1699, as an eleve under the third astronomer; and he read there his "New Theory of Friction," in which he happily cleared up an important object in mechanics. He had a particular genius for making experiments: his notions were just and delicate: he knew how to prevent the inconveniences of his new inventions, and had a wonderful skill in executing them. He died of an inflammation in his bowels, the 11th of October 1705, being only 42 years of age. His pieces are contained in the different volumes of the memoirs of the Academy of Sciences; these are numerous, and upon various subjects, as the air, action of fire, barometers, thermometers, hygrometers, friction, machines, heat, cold, rarefactions, pumps, &c. They may be seen in the volumes for the years 1696, 1699, 1702, 1703, 1704, and 1705. The character of Amontons for integrity, modesty, and candour, was no less distinguished than his talents and genius in philosophical pursuits. Upon his death in 1705, M. Fontenelle delivered an elegant and impressive eulogium on his merits. See Memoirs of the Academy for that year.

AMORPHA, in botany, *bastard indigo*, a genus of plants, belonging to the Diadelphia Decandria class of Linnæus; the flower of which consists of one petal vertically ovated, hollow, and erect; and the fruit is a lunulated pod, of a compressed form, and covered with tubercles, in which are contained two seeds, of an oblong kidney-like shape. There are two species.

This shrub grows naturally in Carolina, where formerly the inhabitants made a coarse sort of indigo, which occasioned its name of the bastard indigo. It rises with many irregular stems to the height of twelve or fourteen feet, with very long-winged leaves. It was observed by Thunberg in the island of Niphon, belonging to Japan, but is now become very common in the gardens and nurseries near London, where it is propagated as a flowering shrub. It is propagated by seeds sent from America.

AMPELIS, in natural history, the *chatterer*, a genus of birds of the order Passeres: bill straight, convex, subincurved, each mandible notched: nostrils covered with bristles: tongue sharp, cartilagenous, bifid: middle toe connected at the base to the outside. There are, according to Gmelin, fourteen species: we shall notice the following: A. garrulus, or waxen chatterer; a beautiful bird about eight inches long. Its bill is black, and has a small notch at the end; its eyes are placed in a band of black, which passes from the base of the bill to the hinder

part of the head. Its throat is black; its feather on the head are long, forming a crest; all the upper parts of the body are of a reddish ash colour; the breast and belly inclining to purple; the tail feathers are black, tipped with pale yellow; the quills are black, the third and fourth tipped on their outer edges with white; the five following with straw colour, but in some, bright yellow; the secondaries are tipped with white, each being pointed with a flat horny substance of a bright vermilion colour. These appendages vary in different subjects. This rare bird visits our island only at uncertain intervals. Their summer residence is supposed to be in the northern parts of Europe, within the arctic circle, whence they spread themselves into other countries, where they remain during the winter, and return in the spring to their usual haunts. The food of this bird is berries of various kinds; in some countries it is said to be extremely fond of grapes. Only this species of the chatterer is found in Europe, the others are natives of America. See Plate I. Aves, fig. 5. A. caruncula, has a black bill, with a pendulous, expansile, moveable caruncle at the base, inhabits Cayenne and Brazil, and is about twelve inches long. The bill is an inch and half long, and black: at the base is a fleshy carbuncle, hanging over it, like that of a turkey cock. The female is furnished with one as well as the male. These birds are said to have a very loud voice, to be heard half a league off, which is composed of merely two syllables, *in*, *an*, uttered in a drawling tone; but some have compared it to the sound of a bell.

AMPELITES, *cannel-coal*, a hard, opaque, fossil, inflammable substance, of a black colour. The ampelites examined by a microscope appears composed of innumerable very small thin plates, laid closely and firmly upon one another, and full of very small specks of a blacker and more shining matter than the rest. There is a large quarry of it in Alençon, in France. It is dug also in many parts of England; but the most beautiful is found in Lancashire and Cheshire: it lies usually at considerable depth. It is capable of a very fine polish, and is made into trinkets, and will pass for jet. Husbandmen dress their vines with it, as it kills the vermin which infests them: it is likewise used for dyeing the hair black.

AMPHIBIA, in natural history, a class of animals that live either on land or in water. The title Amphibia, applied to this class of animals by Linnæus, may perhaps be considered as not absolutely unexceptionable; the power of living with equal facility both in land and water being not granted to all the animals which compose it; yet, since it is certain that the major part are found to possess that faculty in a considerable degree, the title may be allowed to continue. The Amphibia, from the peculiar structure of their organs, and the power which they possess of suspending respiration at pleasure, can not only support a change of element uninjured, but can also occasionally endure an abstinence which would infallibly prove fatal to the higher order of animals. It has been a general doctrine among anatomists, that the hearts of the Amphibia were, in the technical phrase, unilocular, or furnished with only one ventricle or cavity; a doctrine maintained by many eminent anatomists, and, in general, assented to by the greatest physiologists, as Boerhaave, Haller, &c. &c. and only occasionally called in question on viewing in some animals of this tribe a seemingly different structure. Thus the French academicians of the seventeenth century pronounce the heart of an Indian land tortoise, which they examined, to have in reality three ventricles instead of one. Linnæus, in his Systema Naturæ, acquiesces in the general doctrine, and accordingly makes it a character of this class of animals. Among later physiologists, however, there are not wanting some who think it more correct to say, that the hearts of the Amphibia are in reality double, or furnished with two ventricles, with a free or immediate communication between them. The lungs of the Amphibia differ widely in their appearance from those of other animals; consisting, in general, of a pair of large bladders or membranaceous receptacles, parted, in the different species, into more or fewer cancelli, or subdivisions, among which are beautifully distributed the pulmonary blood-vessels, which bear but a small proportion to the vesicular part through which they ramify; whereas, in the lungs of the Mammalia, so great is the proportion of the blood-vessels, and so very small are the vesicles, or air-cells, that the lungs have a fleshy rather than a membranaceous appearance. In the Amphibia, therefore, the vesicular system may be said greatly to prevail over the vascular; and in the Mammalia, or warm-blooded animals, the vascular system to prevail over the vesicular. Many of the Amphibia are possessed of a high degree of reproductive

power, and will be furnished with new feet, tails, &c. when those parts have by any accident been destroyed. Many are highly beautiful in their colours, as well as elegant in their forms; while others, on the contrary, are, in the common acceptation of the words, extremely deformed, and of unpleasing colours. Their bodies are sometimes defended by a hard, horny shield, or covering; sometimes rather by a coriaceous integument; sometimes by scales, and sometimes have no particular defence or coating; the skin being merely marked by soft, pustular warts or protuberances, more or less visible in the different species. The bones of the Amphibia, except in a very few instances, are of a more cartilaginous nature than in either the Mammalia or Birds: many species are destitute of ribs, while others have those parts very numerous: some are furnished with formidable teeth; others are toothless: some are fierce and predacious; others inoffensive. Few, except among the serpent-tribe, are of a poisonous nature; the general prejudice against them having arisen rather on account of their form than from any real poisonous quality; but among the serpents, we meet with some species possessed of the most dreadful poison, as well as with the power of applying it with fatal force to the animals which they attack. The number of poisonous serpents is, however, not so great as was formerly imagined; perhaps not more than a sixth part of the whole number of known species being of that character. Among no animals do we meet with beings of a more singular form than in the Amphibia; some of which present appearances so unusual, so grotesque, and so formidable, that even the imagination of the poet or painter can hardly be supposed to exceed the realities of nature. The Amphibia in general are extremely tenacious of life, and will continue to move, and exert many of their animal functions, even when deprived of the head itself. The experiments which have been occasionally made on these subjects, can hardly be recited without horror. The natural life of some of the Amphibia, more particularly of the tortoise tribe, is extremely long; and even to the smaller tribes of frogs and lizards, a considerable space seems allotted. The same is also highly probable with respect to the serpent-tribe. By far the major part of the Amphibia are oviparous, some excluding eggs covered with a hard or calcareous shell, like those of birds; others, such as are covered only with a tough skin, resembling parchment; and in many, they are perfectly gelatinous, without any kind of external covering, as in the spawn of the common frog. Some few are viviparous; the eggs first hatching internally, and the young being afterwards excluded in their perfect form, as in the viper, &c. &c. In cold and temperate climates, most of the Amphibia pass the winter in a torpid state; and that sometimes in a degree of cold which would seem but ill calculated for the preservation of animal life. The common large water-newt, in particular, is said to have been occasionally found completely imbedded in large masses of ice, in which it must have remained inclosed for a very considerable period; and yet, on the dissolution of the ice, has been restored to life. The Amphibia may be divided into four distributions, viz. Testudines, Ranæ, Lacertæ, and Serpentes; or Tortoises, Frogs, Lizards, and Serpents. The animals belonging to the three former of these divisions constitute the order entitled Reptilia, containing the Amphibia Pedata, or Footed Amphibia. The last division, or that of Serpents, constitutes the order Serpentes; containing the Amphibia Apoda, or Footless Amphibia.

AMPHITRITE, a genus of worms, of the order Mollusca: body projecting from a tube, and annulate: penduncles or feet small, numerous; feelers two, approximate, feathered; no eyes. There are seven species: of which the A. reniformis, with a rounded body and simple feelers, is three inches long, and inhabits the seas about Iceland. The body is of a most beautiful red: head defended by two semicircular arches: plumes fourteen, and alternately red and white: annulations of the body from 80 to 90, with each a minute tubercle on each side: tail pointed, and not jointed: tube red, tough, coriaceous, simple, and four inches long.

AMPHISBÆNA, in natural history, a genus of Serpents, of which the generic character is, body cylindric, equal; annular divisions on body and tail. According to Gmelin there are five species; but Dr. Shaw mentions two only, viz. the Alba and the Fuliginosa. The whole genus is allied to that of the Anguis, and in some degree to the Lacerta; it is, however, readily distinguished by the manner in which the exterior surface of its skin is marked in well-defined numerous circles or rings, completely surrounding the body, and divided in a longitudinal direction by still more numerous straight lines; thus forming so many square

or parallelogramic scales. The alba is about 18 or 20 inches long, and of a proportional thickness. The head, which is covered with large scales, being but little larger in diameter than the body: the tail is short, terminating in a rounded extremity. The colour is, as the name imports, white, though in some instances it is tinged with a pale rose colour. The usual number of circles in this snake is about 223 on the body, and 16 on the tail. It is a native of South America, where it is found in woods, preying on insects and worms. It is a harmless animal; but on being handled, it excites a slight itching on the skin, accompanied by small pustules, owing to an acrimonious moisture exuding from the animal. A. fuliginosa is at all times readily distinguished by its colours. There are about 230 rings on its body and tail. It is white, variegated with black or deep brown spots. The head is without spots. It is found in many parts of South America, resembling the alba in its manners, and being equally innoxious. The skin of the amphisbæna is remarkably strong and tenacious, and of a smooth or glossy surface: it is supposed to be able to perforate the ground with great facility, in the manner of earth worms, to obtain its food. The other species are found in America. See plate Serpentes, fig. 2.

AMPLITUDE, in astronomy, an arch of the horizon intercepted between the east or west point thereof, and the centre of the sun, star, or planet, at its rising and setting, and so is either north or south.

If the amplitude be taken from the rising sun, or star, it is called its rising or ortive amplitude; if when it sets, its setting or occasive amplitude. The sun's amplitude, either rising or setting, is found by the globes, by bringing the sun's place to the horizon, either on the east or west side, and the degrees from the east point, either north or south, are the amplitude required. To find the amplitude trigonometrically, say, as the cosine of the latitude : radius :: sine of the present declination : sine of the amplitude. This problem is useful in navigation, to find the variation of the compass. Thus, in latitude 51° 31′, when the sun's declination is 23° 28′, then we say,

As 60. S. 51° 31′ : 10. &c. :: S. 23° 28′ : S. Amp. or, as 9.793990 : 10. &c. :: 9.600118 : 9.806127 = sine of 39° 47′ = the amplitude sought: that is, the sun then rises or sets 39° 47′ from the east or west point, to the north or south, as the declination is either north or south.

AMPLITUDE, *magnetical*, the different rising or setting of the sun, from the east or west points of the compass. It is found by observing the sun, at his rising and setting, by an amplitude compass. The difference between the magnetical amplitude and the true amplitude is the variation of the compass. If the magnetical amplitude be found to be .... 61° 55′ at the time it is computed as above
to be .... 39° 47′

then the difference 22° 8′ is the variation westward.

AMPLITUDE *of the range of a projectile*, the horizontal line subtending the path in which the projectile moved. See PROJECTILE.

AMPUTATION, in surgery, the cutting off a limb, or other part of the body, with an instrument.

AMULET, a charm, or preservative against mischief, witchcraft, or diseases. Amulets were made of stone, metal, simples, animals, and, in a word, of every thing which fancy or caprice suggested; and sometimes they consisted of words, characters, and sentences, ranged in a particular order, and engraved upon wood, &c. and worn about the neck, or some other part of the body. At other times they were neither written nor engraved, but prepared with many superstitious ceremonies, great regard being usually paid to the influence of the stars. The Arabians have given to this species of amulet the name of talisman.

All nations have been fond of amulets; the Jews were extremely superstitious in the use of them, to drive away diseases: and the Misna forbids them, unless received from an approved man, who had cured at least three persons before, by the same means.

Even amongst the Christians of the early times, amulets were made of the wood of the cross, or ribbands with a text of scripture written in them, as preservatives against diseases; and therefore the council of Laodicea forbids ecclesiastics to make such amulets, and orders all such as wore them to be cast out of the church.

AMYGDALOID. See TRAPS TRANSITION.

AMYGDALUS, in botany, a genus of the Polyandria Monogynia class and order; its characters are, that the calyx is a perianthium, one-leafed, tubulous, inferior, quinquefid, deciduous, divisions spreading and obtuse; the corolla of five petals, oblong-

ovate, obtuse, concave, inserted into the calyx; the stamina have filaments about 30, filiform, erect, shorter by half than the corolla, inserted into the calyx; anthers simple; the pistillum has a roundish, villose germ, simple style, of the length of the stamens, and headed stigma; the pericarpium is a roundish, villose, large drupe, with a longitudinal furrow; the seed is a nut, ovate, compressed, acute, with prominent sutures on each side, reticulated with furrows, and dotted with small holes. The nut of the almond is covered with a dry skin; that of the peach with a small pulp. There are seven species, of which we shall notice, 1. A. persica, with all the serratures of the leaves acute, and the flowers sessile and solitary. There are two varieties, viz. the peach-tree, with downy fruit, and the nectarine, with smooth fruit. 2. A. communis, the almond-tree, with the lower serratures of the leaves glandulous, and the flowers sessile and in couplets. The common almond has leaves which resemble those of the peach, but the lower serratures are glandular; they proceed from buds both above and below the flowers, and not, as in the peach, from the ends of the shoots above and not below the flowers. The form of the flowers is not very different; but they usually come out in pairs, and vary more in their colour from the fine blush of the apple-blossom to a snowy whiteness. The chief obvious distinction is in the fruit, which is flatter, with a coriaceous covering, instead of the rich pulp of the peach and nectarine, opening spontaneously when the kernel is ripe. The shell is not so hard as in the first species, and is sometimes tender and very brittle; it is flatter, smoother, and the furrows or holes are more superficial. This tree is a great object in some parts of Italy, and in the south of France; and there are large plantations of it in Provence and Dauphine. It is common in China, and most of the eastern countries; and also in Barbary, where it is a native. In the time of Cato it seems not to have been cultivated in Italy; for he calls the fruit nuces Græcæ, or Greek nuts. With us it is valuable as an ornamental tree in clumps, shrubberies, &c. within view of the mansion; for it displays its delicate red-purple bloom in the month of March, when few other trees have either leaves or flowers. An almond-tree, covered with its beautiful blossoms, is one of the most elegant objects in nature. In a forward spring they often appear in February; but in this case the frost generally destroys them, and they bear little or no fruit; but when they flower in March, they seldom fail to bear plenty of fruit, very sweet, and fit for the table when green; but they will not keep long. The amygdalus, or almond-tree, is cultivated both for the advantage of the fruit, and as being highly ornamental in shrubberies, plantations, and other descriptions of pleasure ground, from its coming into bloom early in the spring. It is, however, less important in the former than the latter point of view, as the fruit is often liable to miscarry in this climate. All the species and varieties of this tree are deciduous, and of a hardy nature, thriving well in most common garden soils. Those of the tree kind frequently rise to fifteen or twenty feet in height, dividing into many spreading branches, which ultimately form beautiful heads, that are generally well adorned in the beginning of March with innumerable flowers, which continue in full bloom for a fortnight or three weeks, and are followed by the leaves, which are long and narrow, and the fruit takes its growth. This is downy, rather large, and of an oval form; consisting of a thick, tough, leathery substance, that embraces an oblong nut or stone, in which the kernel or almond is inclosed, which is the only part of the fruit that is capable of being made use of. The dwarf, shrubby sorts of this tree do not, however, in general, exceed three or four feet in height, having slender stems, which send forth a great number of small branches near to the ground; and in the single-flowered kind various suckers are frequently sent up from the root. And in both the double and single-flowered almond-tree, all the young branches are thickly beset with flowers in the spring, which, from their having a fine pale red colour, and continuing some time in blow, are highly ornamental. The single sort have their flowers coming out about the end of March, and the double kind in the beginning of April, each remaining about a fortnight in blow. The sorts chiefly cultivated for use in this country are, according to Mr. Forsyth, the tender-shelled almond, the sweet almond, the common, or bitter almond, the sweet Jordan almond, and the hard-shelled almond. Those propagated only for ornament are the dwarf and the double-flowering almonds.——Amygdalus Persica, or peach-tree. Its native country is not known. It came to the Romans from Persia, as its Latin name, *malus Persica,* indicates; and it has been cultivated from time immemorial in most parts of Asia;

it has been adopted by almost every nation of Europe, and now flourishes abundantly in America, where it has been introduced by the Europeans. Of this tree we have only one distinct species; but there are a great many varieties, and by producing them from the seed or kernel, they may be almost indefinitely increased. But though they are capable of being greatly augmented in this manner, it is probable that but very few possess the necessary qualities, as nurserymen seldom cultivate more than twenty or thirty sorts. As in the cultivation of this sort of tree much expense is constantly required in walls or other suitable buildings, none but such as produce fine fruit should be attended to. This sort of trees will grow to a considerable height as standards; but, in order to produce and ripen fruit, requires the shelter of warm walls. They flower early in the spring in common, the flowers appearing before the leaves, mostly on the shoots of the preceding year, and either singly or in pairs along their sides. They are formed each of five small petals, with many stamina in the middle, and a small round germen, that becomes the peach. The fruit is distinguished into two sorts, the peach and pavie, from the circumstances of the flesh or pulp quitting or adhering to the stone, as in the former it easily separates, while in the latter it adheres firmly. There are various sorts of peaches that may be cultivated; but for small gardens Mr. Forsyth recommends the following as the most suitable: the early avant, small mignonne, the Anne peach, royal George, royal Kensington, noblesse, early Newington, Galland, early purple, chancellor, nivette, the Catharine, the late Newington. Amygdalus nucipersica, or the nectarine tree. This is now generally considered as a variety of the peach; but the two trees cannot by any circumstances in their growth, wood, leaves, or flowers, be distinguished from each other with any degree of certainty. The fruits are, however, readily descriminated in all their different stages of growth, that of the nectarine having a smooth, firm cuticle, or rind, while in the peach it is covered with a soft, downy substance. Besides, the pulp or flesh of the former is much more firm than that of the latter. There are many varieties of the nectarine that may be cultivated; but those that chiefly deserve attention are the Fairchild's, the violet, the elrouge, the Newington, the Roman, the temple, and the vermash. The white nectarine may also be cultivated, both for the goodness of its fruit, and as being a curious variety.

AMYRIS, a genus of the Octandria Monogynia class and order; its characters are, that the calyx is a perianthium, one-leafed, four-toothed, acute, erect, small, and permanent; the corolla consists of four oblong, concave, and spreading petals; the stamina have awl-shaped, erect filaments; anthers oblong, erect, of the length of the corolla; the pistillum has a germ, superior, ovate, style thickish, of the length of the stamens, and stigma four-cornered; the pericarpium is a drupaceous and roundish berry; and the seed is a round, shining nut. There are 13 species, of which we shall notice A. sylvatica, with leaves ternate, crinate, and acute. This is an erect, leafy shrub, from two to 15 feet high, according to the soil and situation, abounding with a turpentine of a strong disagreeable smell: it is found plentifully about Carthagena, in woods near the sea, and flowers in August. A. maritima, small, shrubby, sweet-wood, with leaves ternate, crenulated and obtuse. This is a dwarf shrub, yielding a juice like that of the former, but more agreeable, and smelling like rue: the berry is of the size of black pepper, black when ripe, inclosing a globular, brittle nut, in which is a white kernel. Swartz doubts whether the preceding be a distinct species from this. It grows in very barren coppices, in a calcareous rocky soil, both near the sea, and on the interior mountains of Jamaica, Hispaniola, and Cuba, and flowers from June to September. A. gileadensis, balsam of Gilead tree, with leaves ternate, quite entire, and peduncles one-flowered and lateral. This species is a shrub with purplish branches, having protuberant buds loaded with balsamic rosin: the flowers proceed from the same buds by threes; the bracte minute, and slightly bifid. It has been doubted whether this be a distinct species in itself. A. ambrosiaca, with leaves pinnate and petiolate, and panicles crowded and axillary. This is a tree, with a trunk 30 feet high, branching at the top, with branchlets leafy and flowery: leaves alternate, with two or three opposite, ovate leafets on each side, ending in long points, smooth, entire, on short petioles, gibbous at the base; flowers yellowish white, axillary, and corymbed; perianth very small and four-toothed; petals lanceolate, spreading at the tip; filaments filiform, half as long as the calyx, inserted into the tube; germ superior, subglobose, style cylindrical; stigma capitated, depressed, and four-cor-

nered; fruit vate, oblique, four-celled, resembling that of the laurel; the nucleus involved in a brittle covering, four-celled, with four stones wrapped up in a viscid red pulp, having a balsamic smell and taste, hardening into a grey rosin, and used for burning as a perfume. The whole tree is sweet-scented, and yields a very odoriferous balsam from the wounded trunk or branches, which is used in the dysentery; the dose is one dram in red wine; it is also used in houses and churches for burning as a perfume. It grows in the woods of Guiana, and by the sea-shore; flowering and fruiting in September. A. balsamifera, sweet amyris, white candle-wood, or rosewood, with leaves two-paired. This grows to a considerable size, and is one of the most valuable trees in the island of Jamaica; the wood is white, and of a curled grain when young, but grows of a dirty, clouded ash colour with age, bearing a fine polish, and having a pleasant smell; it is heavy, and much esteemed among cabinet-makers. All the parts of this tree are full of warm, aromatic particles, and may be used in baths and fomentations; the berries are oblong, and have the taste of the balsam copaiba. An infusion of the leaves has a pleasant flavour, is highly cephalic, strengthens the nerves, and is particularly restorative to weak eyes. In Jamaica there are several species of amyris, the leaves and bark of which yield a fine balsamic juice; and if the body were tapped at the proper season, a thick liquor would transude, resembling that of the Gilead balsam, to which the taste of the bark and wood of the smaller branches bears a very exact relation. Dr. Wright apprehends that this wood, by distillation, would yield a perfume equal to the oleum rhodii.

ANA, among physicians, denotes an equal quantity of the ingredients which immediately precede it in prescriptions: it is written by abbreviation $\bar{a}$ or $\bar{a}\,\bar{a}$; thus, ℞ *thur. myrrh. alum.* $\bar{a}\,\bar{a}$, ℈j: that is, take frankincense, myrrh, and alum, each a scruple.

Ana, in matters of literature, a Latin termination added to the titles of several books in other languages.

They are collections of the conversation and memorable sayings of men of wit and learning; the Scaligeriana was the first book that appeared with a title in *ana*, and was afterwards followed by the Perroniana, Thuana, Naudæana, Menagiana, and even by Arlequiniana, in ridicule of all books in *ana*. The Menagiana are accounted the best.

Ana, among occult philosophers, a term used to denote the human mind; from whence some will have *anasapta*, a dæmon invoked by sick persons, to be derived.

ANABASIS, in botany, a genus of the Pentandria Digynia class and order: essen. char.; calyx, three-leaved; cor. five-petalled; berry one-seeded, surrounded by a calyx: there are four species.

ANACARDIUM, in botany, *acajou*, a genus of the Enneandria Monogynia class and order; its characters are, that it has hermaphrodite flowers, and male flowers, either mixed with the hermaphrodites, or on a distinct tree. The calyx of the former is a perianthium, five-leaved, leaflets ovate, concave, coloured, erect, and deciduous; the corolla has five petals, lanceolate, acute, three times as long as the calyx, upright at bottom, reflex at the end; the stamina have ten filaments, united at the base and upright, nine of them capillary, shorter than the calyx; the pistillum has a germ, kidney-shaped, obliquely emarginate in front, style subulate, bent in, the length of the corolla; stigma small, roundish, depressed, and concave: no pericarpium; receptacle fleshy, very large and obovate; the seed a nut, kidney-shaped, large at the top of the receptacle, with a thick shell, cellular within, and abounding in oil. The calyx, corolla, and stamina, of the male flowers, as in the hermaphrodites; the pistillum has either no germ, or one that is abortive. There is one species. viz. A. occidentale, cashew-nut, cassu or acajou. The cashew is an elegant tree, 12 or 16 feet high, spreading much as it rises, and beginning to branch at the height of five feet, according to Browne; but Long affirms that in good soils it spreads to the size of a walnut tree, which it resembles in the shape and smell of the leaves: the trunk seldom exceeds half a foot in diameter; the leaves are coriaceous, subovate, shining, entire, petioled, and scattered alternately; and terminating, containing many small, sweet-smelling flowers, on an oblong receptacle, scarcely distinguishable from the peduncle; the corolla red, with commonly 10 stamens, one of which has no anther, but it has frequently eight, or only seven, all fertile; and there are sometimes female flowers entirely destitute of stamens. The fruit has an agreeable subacid flavour, in some degree restringent; in some of a yellow, and in others of a red colour, which difference may be probably owing to the soil or culture. The juice of the fruit, fermented, affords a pleasant wine; and dis-

tilled, yields a spirit exceeding arrack or rum, and serves to make punch, and also to promote urine. The ripe fruit is sometimes roasted and sliced, and thus used for giving an agreeable flavour to punch. The restringency of the juice has recommended it as a remedy in dropsical habits. From one end of the apple proceeds the nut, which is kidney-shaped, inclosed in two shells, the outer of an ash colour, and smooth, and the inner covers the kernel. Between these shells is lodged a thick, inflammable, and very caustic oil, which, incautiously applied to the lips and mouth, inflames and excoriates them. This oil has been successfully used for eating off ring-worms, cancerous ulcers, and corns; but it should be very cautiously applied. Some females have used it as a cosmetic, in order to remove the freckles and tan occasioned by the scorching rays of the sun, but it proves so corrosive as to peel off the skin, and cause the face to inflame and swell; but after enduring the pain of this operation for about a fortnight, thin new skin, as it may be called, appears fair like that of a new-born infant. This oil also tinges linen of a rusty iron colour, that can hardly be got out; and when smeared on wood it prevents decay, and might, therefore, serve for preserving house timber and ships' bottoms. The fresh kernel has a delicious taste, and abounds with a sweet milky juice; it is an ingredient in puddings, &c. and is eaten raw, roasted, and pickled. The negroes of Brazil, who are compelled by their masters, the Portuguese, to eat this nut, for want of other sustenance, obtain relief from this involuntary use of it in various disorders of the stomach. When the kernel is ground with cacao, it improves the chocolate; but if it be kept too long it becomes shrivelled, and loses its flavour and best qualities. The milky juice of the tree, obtained by tapping or incision, will stain linen of a deep black, which cannot be washed out; but whether this has the same property with that of the eastern anacardium, has not yet been ascertained; for the inspissated juice of that tree is the best sort of lac which is used for staining black in China or Japan.

ANACHRONISM, in matters of literature, an error with respect to chronology, whereby an event is placed earlier than it really happened, in which sense it stands opposite to parachronism.

ANACREONTIC *verse*, in ancient poetry, a kind of verse, so called from its being much used by the poet Anacreon. It consists of three feet and a half, usually spondees and iambics, and sometimes anapests; such is that of Horace,

Lydia dic per omnes.

The word anacreontic is sometimes placed at the beginning of convivial songs, glees, &c. denotes a gay hilarity of movement, and a free and easy style of performance.

ANACYCLUS, in botany, a genus of plants of the Syngenesia Polygamia Superflua. Essen. char. receptacle chaffy, seeds crowned with an emarginate margin, those at the ray membranaceous at the sides. There are five species: of which the creticus and orientalis grow naturally in the islands of the Archipelago. They are low plants, whose branches trail on the ground. The first sort has fine cut leaves, like those of chamomile; the flowers are small, white, and grow single with their heads declining; these are like those of common may-weed. The second has leaves like those of the ox-eye; the flowers are white, and like those of chamomile.

ANAGALLIS, in botany, a genus of plants, belonging to the Pentandria Monogynia class of Linnæus; the flower of which is monopetalous, multifid, and orbicular; the fruit is a globose capsule, containing only one cell, and dividing horizontally into two hemispheres; the seeds are numerous and angular. There are six species.

ANAGRAM, in matters of literature, a transposition of the letters of some name, whereby a new word is formed, either to the advantage or disadvantage of the person or thing to which the name belongs; thus, from Galenus is formed Angelus: from James, Simea; and so of others.

Those who adhere strictly to the definition of an anagram, take no other liberty than that of omitting or retaining the letter *h*, at pleasure; whereas others make no scruple to use *e* for *æ*, *v* for *w*, *s* for *z*, and *c* for *k*: and vice versa.

ANAGYRIS, *bean-trefoil*, in botany, a genus of plants with papilionaceous flowers, the vexillum of which is shorter than any of the other petals, and its fruit an oblong pod, containing kidney-like seeds: to this it is to be added, that three leaves stand on every petal. It belongs to the Diadelphia Decandria class of Linnæus.

According to Martyn, there are three species: viz. the fœtida, cretica, and inodorata. The first grows wild in the South of France, in Spain, Italy, and Sicily; also

about Smyrna. It is a shrub that rises 8 or 10 feet high, and produces its flowers in April and May, which are of a bright yellow colour, growing on spikes, somewhat like those of the laburnum: the seeds are never perfected in this country. The second is a native of Canada, and some of the islands of the Archipelago, and is very rare in English gardens. The third is an upright shrub, equal to a middle-sized tree: branches hanging down, frequently scandent: a native of the woods of Cochinchina.

These may be propagated by laying down their tender branches in the spring, observing to tongue them in the same manner as the layers of carnations.

ANALCIME, in mineralogy, a species of Zeolite, found crystallised in the cavaties of basalt. The primitive form of its crystals is a cube. It is sometimes found crystallised in cubes, whose solid angles are wanting, and three small triangular faces in place of each; sometimes in polyhedrons with twenty-four faces. Specific gravity 2. Colour white, sometimes red. When rubbed it acquires only a small degree of electricity, and with difficulty. Before the blow-pipe it melts without frothing into a white transparent glass.

ANALEMMA, in geometry, a projection of the sphere on the plane of the meridian, orthographically made by straight lines and ellipses, the eye being supposed at an infinite distance; and in the east or west points of the horizon. See MAPS.

ANALEMMA denotes likewise an instrument of brass or wood, upon which this kind of projection is drawn, with an horizon and cursor fitted to it, wherein the solstitial colure, and all circles parallel to it, will be concentric circles; all circles oblique to the eye will be ellipses; and all circles whose planes pass through the eye, will be right lines. The use of this instrument is to shew the common astronomical problems.

ANALOGY, in matters of literature, a certain relation and agreement between two or more things; which in other respects are entirely different; thus the foot of a mountain bears an analogy to the foot of an animal, although they are two very different things.

There is likewise an analogy between beings that have some conformity or resemblance to one another; for example, between animals and plants, and between metals and vegetables; but the analogy is still stronger between two different species of certain animals.

ANALOGY, among grammarians, is the correspondence which a word or phrase bears to the genius and received forms of a language.

ANALYSIS, in a general sense, is the resolution of something compounded, into its constituent parts. Hence,

ANALYSIS, in chemistry, is the separation of any substance into its constituent parts, with a view of ascertaining their nature, relative proportion, and mode of union. An instance of this kind is to be had in the decomposition of water, by which it is found that the constituent parts are hydrogen and oxygen, in the proportion of fifteen parts of the former and eighty-five parts of the latter. As every operation in chemistry is attended with a disunion of parts, the formation of new compounds is almost an invariable consequence: hence the business of analysis, is intimately connected with the whole of chemical science, and can be only thoroughly understood by one that is well versed in every branch of chemistry. On so an extensive a subject it is in vain to attempt laying down precise rules for the mode of operation generally. We may, however, observe that a compound once formed, perpetually acquires the powers of an element, in being able to unite, undecomposed, with other bodies simple or compounded, in various proportions; and thus to produce new substances in which the constituent parts often retain their original affinities, and in analysis again separate into their elementary substances. We may refer to nitrate of ammonia, which is a salt composed of nitric acid, ammonia, and water, each of which is itself a compound, but in this particular combination it acts as an elementary body: thus, nitric acid consists of azote and oxygen: ammonia, of azote and hydrogen: and water, as we have seen, of oxygen and hydrogen: so that in truth there are only azote, hydrogen, and oxygen, that enter into the combination of nitrate of ammonia; but in their simple state they cannot be made to form the salt: it is requisite that the acid, the alkali, and the water, should be first formed, in order to get the neutral salt.

The business of chemical analysis is to resolve a body into its constituent parts; but the first question is to determine, in every instance of analysis, whether the resolution should proceed to entire separation into real elements, or only into those compounds which act as elements, as in the case referred to, whether the nitrate of ammonia should be

resolved into azote, hydrogen, and oxygen: or whether it should not first be reduced into nitric acid, ammonia, and water. The former mode is best calculated for research, the latter for utility; but a mixture of the two methods is commonly adopted, where the proportion and nature of the compound produced has already been fully ascertained by previous experiment. The most rigid proof of the accuracy of analysis, is to be able to produce the same compound by uniting the identical parts which we have given as its constituents. This can rarely be performed in a manner perfectly satisfactory, but it frequently happens that a substance may be reproduced that resembles the one analysed, by employing similar constituents, if not the identical substances. This proof even is almost totally wanting in the analysis of organised bodies, whether vegetable or animal, especially when reduced to their ultimate elements, and generally when only separated into their immediate constituents. The agents made use of in analysis, are heat, the electric and galvanic fluids, if they are two fluids, and the application of re-agents or substances, which indicate the parts of the body to be examined.

Analysis, among logicians, is a method of tracing things backward to their source, and of resolving knowledge into its original principles. It is also called the method of resolution, and stands opposed to the synthetic method, or method of composition. The art of this method consists chiefly in combining our perceptions, and classing them together with address; and in contriving a proper expression of our thoughts, so as to represent their several divisions, classes, and relations. This is clearly seen in the manner of computing by figures in arithmetic, but more particularly in the symbols applied in resolving algebraical problems.

Analysis, among mathematicians, the art of discovering the truth or falsehood of a proposition, or its possibility and impossibility. This is done by supposing the proposition, such as it is, true; and examining what follows from thence, until we arrive at some evident truth, or some impossibility, of which the first proposition is a necessary consequence; and from thence establish the truth or impossibility of that proposition.

The analysis of the ancient geometricians consisted in the application of the propositions of Euclid, Apollonius, &c. till they arrived, proceeding step by step, at the truth required. That of the moderns, though not so elegant, must, however, be allowed more ready and general. By this last, geometrical demonstrations are wonderfully abridged, a number of truths are frequently expressed by a single line, and whole sciences may sometimes be learned in a few minutes, which otherwise would be scarcely attained in many years.

Analysis is divided, with regard to its object, into that of finites and infinites. Analysis of infinite quantities, that which is called specious arithmetic. Analysis of infinites, the same with fluxions. See Fluxions.

Analysis, in minerology, includes the examination of metallic ores, and of the other products of the mineral kingdom. See Minerals, *analysis of*.

Analysis *of soils*, the means of ascertaining the nature, properties, and proportions of the different materials of which they are composed. The proper execution of this business enables the farmer to form a just estimate of the value of the different parts of his lands, to make the application of ameliorating substances with propriety, and to understand the effects that may be produced by the combinations of different matters. The apparatus necessary for this business are scales and weights of different sizes; some porcelain, glass, or stone-ware vessels, unglazed; some muriatic and sulphuric acid, alkali, galls, and pure distilled water.

ANAMORPHOSIS, in perspective and painting, a monstrous projection, or representation of an image on a plane or curve surface, which, beheld at a proper distance, shall appear regular and in proportion.

To delineate an an amorphosis upon a plane: 1. Draw the square A B C D, (Plate I. Miscel. fig. 4.) of a bigness at pleasure, and subdivide into a number of little squares. 2. In this square, called the craticular prototype, let the image to be represented deformed, be drawn. 3. Then draw the line *a b* (ibid. fig. 5.) equal to A B, and divide it into the same number of equal parts as the side of the prototype A B. 4. Erect the perpendicular E V, in the middle of *a b*, so much the longer as the deformity of the image is to be greater. 5. Draw V S perpendicular to E V, so much the shorter as you would have the image appear more deformed. From each point of division draw strait lines to V, and join the points *a* and S, by the right line *a* S. 6. Through the points *d e f g* draw right lines parallel to *a b*, then will *a b c d* be the space in which the

monstrous projection is to be delineated: this space is called the craticular ectype. Lastly, in every areola, or small trapezium, of the space *a b c d*, draw what appears delineated in the correspondent areola of the square ABCD; and thus you will obtain a deformed image, which will appear in just proportion to an eye distant from it the length of FV, and raised above its height VS.

An image may be deformed mechanically, if you place it, having little holes made here and there in it with a needle, against a candle, and observe where the rays going through these holes, fall on a plane or curve surface; for they will give the corresponding points of the image to be deformed.

The practical methods of drawing these images is described in the Leipsic Act for the year 1712, where we have an account of two machines, one for images viewed with a cylindrical, and the other with a conical mirror. The person who has this instrument may take any point at pleasure, and while he goes over the outlines of it with one pen, another traces the anamorphosis.

In the cloister of the Minims at Paris, there are two anamorphoses traced upon two of the sides of the cloister, one representing a Magdalen, and the other St. John writing his gospel. They are so managed, that when viewed directly they appear like a kind of landscape, but from a particular point of sight they appear very distinctly, like human figures.

ANANAS. See Bromelia.

ANAPÆST, in ancient poetry, a foot consisting of two short syllables and one long; such is the word scŏpŭlōs. It is just the reverse of the dactyl.

ANAPHORA, in rhetoric, a verbal figure, whereby one or more words are repeated in the beginning of several sentences. This is a lively and elegant figure, and serves very much to engage the attention; for by the frequent return of the same word, the mind of the hearer is held in an agreeable suspense till the whole is finished. Such is that in the Psalms; "The voice of the Lord is powerful; the voice of the Lord is full of majesty: the voice of the Lord shaketh in the wilderness." Another from Cicero's fine oration against Catiline; "You do nothing, you attempt nothing, you think nothing, but what I not only hear, but also see and plainly perceive."

ANARCHICHAS, in natural history, *wolf-fish*, a genus of fishes of the order Apodes: head rounded, blunt; fore-teeth in each jaw conic, large, divergent, six or more; grinders in the lower jaw and palate rounded; gill-membrane seven-rayed; body roundish, caudal-fin distinct. There are three species. A. lupus, or ravenous wolf-fish, inhabits the northern seas; grows to 15 feet long; it is a most fierce and ravenous fish, and will fasten on any thing within its reach. It feeds on shell-fish, which it grinds to pieces with its teeth, and swallows shells and all: moves slowly with something of a serpentine motion; the grinders are often found fossile, and are called toad-stones: the flesh is good, but not often eaten. The fossile teeth were formerly much esteemed for imaginary virtues, and were set in gold and worn as rings. Notwithstanding the ferocity of this fish, which is as dreadful to the small inhabitants of the water, as the wolf is to those on land, it is sometimes attacked and destroyed by an enemy of far inferior size and strength, viz. the cyclopterus, or lump-fish, which fastening itself on its neck, adheres immoveably, tormenting it in such a manner as to cause its death. The wolf-fish frequents the deep part of the sea, and in the spring approaches the coast, in order to deposit its spawn among marine plants: the ova are about the size of peas; and the young are of a greenish cast, like that of sea-wrack, among which they reside for some time after their birth. See Plate I. Pisces, fig. 3. A. minor is found in the Greenland seas; and the A. pantherinus inhabits the Northern and Frozen Ocean.

ANARRHINUM, in botany, a genus of the Didynamia Angiosperma class and order: calyx five-leaved; coral with a nectariferous prominence at its base pointing downwards; the upper-lip flat, without palate, and the orifice pervious; capsule two-celled, many-valved. There are five species.

ANAS, in natural history, a genus of birds of the order Anseres. The bill in this genus is strong, broad, flat or depressed, and commonly furnished at the end with an additional piece termed a nail, the edges of the mandibles marked with sharp teeth; nostrils small, oval: tongue broad, edges near the base fringed; toes four, three before and one behind, the middle one the longest. According to Latham, there are 98 species, besides varieties; but Gmelin gives about 120 species.

From the swan downward to the teal, they

are all a clean-plumaged beautiful race of birds, and some of them exquisitely so. Those which have been reclaimed from a state of nature, and live dependant on man, are extremely useful to him: under his protection they breed in great abundance, and, without requiring much of his time and care, lead their young to the pool, almost as soon as hatched, where they instantly, with instinctive perception, begin to search for their food, which at first consists chiefly of weeds, worms, and insects; those they sift, as it were, from the mud, and for that purpose their bills are admirably adapted. When they are farther advanced in life, they pick up the sodden scattered grain of the farm-yard, which, but for their assiduous searchings, would be lost. To them also are allotted the larger quantities of corn which are shaken by the winds from the over-ripened ears in the fields. On this clean and simple food they soon become fat, and their flesh is accounted delicious and nourishing. In a wild state, birds of various kinds preserve their original plumage; but when tamed, they soon begin to vary, and shew the effects of domestication: this is the case with the tame goose and the duck, which differ as much from the wild of their respective kinds, as they do from each other. We shall notice the following, as among the most interesting of the species.

Anas Cygnus Ferus, the wild swan, measures five feet in length, and above seven in breadth, and weighs from thirteen to sixteen pounds. The bill is three inches long, of a yellowish white; from the base to the middle, and thence to the tip, black; the bare space from the bill over the eye and eye-lids is yellow: the whole plumage in adult birds is of a pure white, and, next to the skin, they are cloathed with a thick fine down: the legs are black. This species generally keeps together in small flocks, or families, except in the pairing season, and at the setting in of winter. At the latter period they assemble in immense multitudes, particularly on the large rivers and lakes of the thinly-inhabited northern parts of Europe, Asia, and America: but when the extremity of the weather threatens to become insupportable, in order to shun the gathering storm they shape their course high in air, in divided and diminished numbers, in search of milder climates. In such seasons they are most commonly seen in various parts of the British isles, and in other more southern countries of Europe. The same is observed of them in the North American states. They do not, however, remain longer than till the approach of the spring, when they again retire northward to the arctic regions to breed. A few, indeed drop short, and perform that office by the way, for they are known to breed in some of the Hebrides, the Orkney, Shetland, and other solitary isles; but these are hardly worth notice: the great bodies of them are met with in the large rivers and lakes near Hudson's Bay, and those of Kamtschatka, Lapland, and Iceland. They are said to return to the latter place in flocks of about a hundred at a time in the spring, and also to pour in upon that island from the north, in nearly the same manner. on their way southward, in the autumn. The young which are bred there remain throughout the first year; and in August, when they are in moult, and unable to fly, the natives taking advantage of this, kill them with clubs, shoot, and hunt them down with dogs, by which they are easily caught. The flesh is highly esteemed by them as a delicious food, as are also the eggs, which are gathered in the spring. The Icelanders, Kamtscatdales, and other natives of the northern world, dress their skins with the down on, sew them together, and make them into garments of various kinds: the northern American Indians do the same, and sometimes weave the down as barbers weave the cauls for wigs, and then manufacture it into ornamental dresses for the women of rank, while the larger feathers are formed into caps and plumes to decorate the heads of their chiefs and warriors. They also gather the feathers and down in large quantities, and barter or sell them to the inhabitants of more civilized nations. Much has been said of the singing of the swan, in ancient times, and many beautiful and poetical descriptions have been given of its dying song. No fiction of natural history, no fable of antiquity, was ever more celebrated, often repeated, or better received: it occupied the soft and lively imagination of the Greeks; poets, orators, and even philosophers, adopted it as a truth too pleasing to be doubted. The dull insipid truth, however, is very different from such amiable and affecting fables, for the voice of the swan, singly, is shrill, piercing, and harsh, not unlike the sound of a clarionet when blown by a novice in music. It is, nevertheless, asserted by those who have heard the united and varied voices of a numerous assemblage of them, that they produce a more harmonious effect, particu-

larly when softened by the murmur of the waters. At the setting in of frosty weather, the wild swans are said to associate in prodigious multitudes, and, thus united, to use every effort to prevent the water from freezing: this they accomplish by the continual stir kept up amongst them; and by constantly dashing it with their extended wings, they are enabled to remain as long as it suits their convenience, in some favourite part of a lake or river which abounds with their food. The swan is very properly entitled the peaceful monarch of the lake: conscious of his superior strength, he fears no enemy, nor suffers any bird, however powerful, to molest him; neither does he prey upon any one. His vigorous wing is as a shield against the attacks even of the eagle, and the blows from it are said to be so powerful as to stun or kill the fiercest of his foes. The wolf or the fox may surprise him in the dark, but their efforts are vain in the day. His food consists of the grasses and weeds, and the seeds and roots of plants which grow on the margins of the water, and of the myriads of insects which skim over, or float on its surface; also occasionally of the slimy inhabitants within its bosom. The female makes her nest of the withered leaves and stalks of reeds and rushes, and lays commonly six or seven thick-shelled white eggs: she is said to sit upon them six weeks before they are hatched. Both male and female are very attentive to their young, and will suffer no enemy to approach them.

Anas Cygnus Mansuetus, or mute swan. The plumage of this species is of the same snowy whiteness as that of the wild swan, and the bird is covered next the body with the same kind of fine close down; but it greatly exceeds the wild swan in size, weighing about twenty-five pounds, and measuring more in the length of the body and extent of the wings. This also differs in being furnished with a projecting, callous, black tubercle, or knob, on the base of the upper mandible, and in the colour of the bill, which in this is red, with black edges and tip; the naked skin between the bill and the eyes is also of the latter colour: in the wild swan this bare space is yellow. The swan, although possessed of the power to rule, yet molests none of the other water-birds, and is singularly social and attentive to those of his own family, which he protects from every insult. While they are employed with the cares of the young brood, it is not safe to approach near them, for they will fly upon any stranger, whom they often beat to the ground by repeated blows; and they have been known by a stroke of the wing to break a man's leg. But, however powerful they are with their wings, yet a slight blow on the head will kill them. The swan, for ages past, has been protected on the river Thames as royal property; and it continues at this day to be accounted felony to steal their eggs. "By this means their increase is secured, and they prove a delightful ornament to that noble river." Latham says, "In the reign of Edward IV. the estimation they were held in was such, that no one who possessed a freehold of less than the clear yearly value of five marks, was permitted even to keep any." In those times, hardly a piece of water was left unoccupied by these birds, as well on account of the gratification they gave to the eye of their lordly owners, as that which they also afforded when they graced the sumptuous board at the splendid feasts of that period: but the fashion of those days is passed away, and swans are not nearly so common now as they were formerly, being by most people accounted a coarse kind of food, and consequently held in little estimation; but the cygnets (so the young swans are called) are still fattened for the table, and are sold very high, commonly for a guinea each, and sometimes for more: hence it may be presumed, they are better food than is generally imagined. This species is said to be found in great numbers in Russia and Siberia, as well as further southward, in a wild state. They are, without an owner, common on the river Trent, and on the salt-water inlet of the sea near Abbotsbury, in Dorsetshire: they are also met on other rivers and lakes in different parts of the British isles. The female makes her nest, concealed among the rough herbage, near the water's edge: she lays from six to eight large white eggs, and sits on them about six weeks (some say eight weeks) before they are hatched. The young do not acquire their full plumage till the second year. It is found by experience that the swan will not thrive if kept out of the water: confined in a court yard, he makes an aukward figure, and soon becomes dirty, tawdry, dull, and spiritless.

Anas Canadensis, or Canada goose, is another useful species, which has been reclaimed from a state of nature, and domesticated and multiplied in many parts of Europe, particularly in France and Ger-

many; and it is not very uncommon in England. It is as familiar, breeds as freely, and is in every respect as valuable as the common goose; it is also accounted a great ornament on ponds near gentlemen's seats. Mr. Pennant, in his Arctic Zoology, gives the following interesting account of the mode of taking the Canada goose in Hudson's Bay: "The English of Hudson's Bay depend greatly on geese, of these and other kinds, for their support; and, in favourable years, kill three or four thousand, which they salt and barrel. Their arrival is impatiently attended; it is the harbinger of the spring, and the month named by the Indians the Goose Moon. They appear usually at our settlements in numbers, about St. George's Day, O. S., and fly northward to nestle in security. They prefer islands to the continent, as further from the haunts of men. Thus, Marble Island was found, in August, to swarm with swans, geese, and ducks; the old ones moulting, and the young at that time incapable of flying." "The English send out their servants, as well as Indians, to shoot these birds on their passage. It is in vain to pursue them: they therefore form a row of huts made of boughs, at musquet-shot distance from each other, and place them in a line across the vast marshes of the country. Each hovel, or, as they are called, stand, is occupied by only a single person. These attend the flight of the birds, and, on their approach, mimic their cackle so well, that the geese will answer, and wheel and come nearer the stand. The sportsman keeps motionless, and on his knees, with his gun cocked, the whole time, and never fires till he has seen the eyes of the geese. He fires as they are going from him, then picks up another gun that lies by him, and discharges that. The geese which he has killed he sets up on sticks, as if alive, to decoy others; he also makes artificial birds for the same purpose. In a good day (for they fly in very uncertain and unequal numbers) a single Indian will kill two hundred. Notwithstanding every species of goose has a different call, yet the Indians are admirable in their imitation of every one."—"The vernal flight of the geese lasts from the middle of April until the middle of May. Their first appearance coincides with the thawing of the swamps, when they are very lean. The autumnal, or the season of their return with their young, is from the middle of August to the middle of October. Those which are taken in this latter season, when the frosts usually begin, are preserved in their feathers, and left to be frozen, for the fresh provisions of the winter stock. The feathers constitute an article of commerce, and are sent into England."

Anas Anser, or tame goose. To describe the varied plumage and the economy of this well-known and valuable domestic fowl, may seem to many a needless task; but to others, unacquainted with rural affairs, it may be interesting. Their predominant colours are white and grey, with shades of ash, blue, and brown: some of them are yellowish, others dusky, and many are found to differ very little in appearance from the wild kind last described—the original stock whence, in early times, they were all derived. The only permanent mark, which all the grey ones still retain, like those of the wild kind, is the white ring which surrounds the root of the tail. They are generally furnished with a small tuft on the head, and the most usual colour of the males (gander or stig) is pure white: the bills and feet in both males and females are of an orange-red. By studied attention in the breeding, two sorts of these geese have been obtained: the less are by many esteemed as being more delicate eating; the larger are by others preferred on account of the bountiful appearance they make upon the festive board. The average weight of the latter kind is between nine and fifteen pounds; but instances are not wanting, where they have been fed to upwards of twenty pounds: this is, however, to sacrifice the flavour of the food to the size and appearance of the bird, for they become disgustingly fat and surfeiting, and the methods used to cram them up are unnatural and cruel. It is not, however, altogether on account of their use as food that they are valuable; their feathers, their down, and their quills have long been considered as articles of more importance, and from which their owners reap more advantages. In this respect the poor creatures have not been spared; urged by avarice, their inhuman masters appear to have ascertained the exact quantity of plumage of which they can bear to be robbed, without being deprived of life. Mr. Pennant, in describing the methods used in Lincolnshire, in breeding, rearing, and plucking geese, says, "they are plucked five times in the year; first at Lady-day for the feathers and quills: this business is renewed for the feathers only, four times more between that and Michaelmas;" he adds, that he saw the ope-

ration performed even upon goslings of six weeks old, from which the feathers of the tails were plucked; and that numbers of the geese die when the season afterwards proves cold. But this unfeeling greedy business is not peculiar to one country, for much the same is practised in others. The care and attention bestowed upon the brood geese, while they are engaged in the business of incubation, in the month of April, is nearly the same every where: wicker-pens are provided for them, placed in rows, and tier above tier, not uncommonly under the same roof as their owner. Some place water and corn near the nests; others drive them to the water twice a day, and replace each female upon her own nest as soon as she returns. This business requires the attendance of the gozzard (goose-herd) a month at least, in which time the young are brought forth: as soon afterwards as the brood are able to waddle along, they are, together with their dams, driven to the contiguous loughs and fens or marshes, on whose grassy margined pools they feed and thrive, without requiring any further attendance until the autumn. To these marshes, which otherwise would be unoccupied, (except by wild birds) and be only useless, watery wastes, we are principally indebted for so great a supply of the goose; for in almost every country, where lakes and marshes abound, the neighbouring inhabitants keep as many as suit their convenience; and in this way immense numbers annually attain to full growth and perfection; but in no part of the world are such numbers reared, as in the fens of Lincolnshire, where it is said to be no uncommon thing for a single person to keep a thousand old geese, each of which, on an average, will bring up seven young ones. So far those only are noticed which may properly be called the larger flocks, by which particular watery districts are peopled; and, although their aggregate numbers are great, yet they form only a part of the large family: those of the farm-yard, taken separately, appear as small specks on a great map; but when they are gathered together, and added to those kept by almost every cottager throughout the kingdom, the immense whole will appear multiplied in a ratio almost incalculable. A great part of those which are left to provide for themselves during the summer, in the solitary distant waters, as well as those which enliven the village green, are put into the stubble fields after harvest, to fatten upon the scattered grain; and some are penned up for this purpose, by which they attain to greater bulk; and it is hardly necessary to observe, that they are then poured in weekly upon the tables of the luxurious citizens of every town in the kingdom. But these distant and divided supplies seem trifling when compared with the multitudes which, in the season, are driven in all directions into the metropolis: the former appear only like the scanty waterings of the petty streamlet; the latter like the copious overflowing torrent of a large river. To the country market towns they are carried in bags and panniers; to the great centre of trade they are sent in droves of many thousands. To a stranger it is a most curious spectacle to view these hissing, cackling, gabbling, but peaceful armies, with grave deportment, waddling along, (like other armies) to certain destruction. The drivers are each provided with a long stick, at one end of which a red rag is tied as a lash, and a hook is fixed at the other: with the former, of which the geese seem much afraid, they are excited forward; and with the latter, such as attempt to stray, are caught by the neck and kept in order; or if lame, they are put into a hospital-cart, which usually follows each large drove. In this manner they perform their journies from distant parts, and are said to get forward at the rate of eight or ten miles in a day, from three in the morning till nine at night: those which become fatigued are fed with oats, and the rest with barley. The tame goose lays from seven to twelve eggs, and sometimes more: these the careful housewife divides equally among her brood geese, when they begin to sit. Those of her geese which lay a second time in the course of the summer, are seldom, if ever, permitted to have a second hatching; but the eggs are used for household purposes. In some countries the domestic geese require much less care and attendance than those of this country. The goose has for many ages been celebrated on account of its vigilance. The story of the saving of Rome by the alarm they gave, when the Gauls were attempting the Capitol, is well known, and was probably the first time of their watchfulness being recorded, and, on that account, they were afterwards held in the highest estimation by the Roman people. It is certain, that no thing can stir in the night, nor the least or most distant noise be made, but the geese are roused, and immediately begin to hold their cackling converse; and on the nearer approach of apprehended danger, they set

up their more shrill and clamorous cries. It is on account of this property that they are esteemed by many persons as the most vigilant of all sentinels, when placed in particular situations.

Anas Erythropus, or barnacle. The barnacle weighs about five pounds, and measures more than two feet in length, and nearly four and a half in breadth. The bill, from the tip to the corners of the mouth, is scarcely an inch and a half long, black and crossed with a pale reddish streak on each side: a narrow black line passes from the bill to the eyes, the irides of which are brown: the head is small, and as far as the crown, together with the cheeks and throat, white: the rest of the head and neck, to the breast and shoulders, is black. The upper part of the plumage is prettily marbled or barred with blue-grey, black, and white: the feathers of the back are black, edged with white, and those of the wing-coverts and scapulars blue-grey, bordered with black near their margins, and edged with white: the quills black, edged a little way from the tips with blue-grey: the under parts and tail coverts white: the thighs are marked with dusky lines or spots, and are black near the knees: the tail is black, and five inches and a half long: the legs and feet dusky, very thick and short, and have a stumpy appearance. In severe winters, these birds are not uncommon in this kingdom, particularly in the northern and western parts, where, however, they remain only a short time, but depart early in the spring to their northern wilds, to breed and spend the summer.

Anas molissima, or eider duck. This wild, but valuable species, is of a size between the goose and the domestic duck, and appears to be one of the graduated links of the chain which connects the two kinds. The full-grown old males generally measure about two feet two inches in length, and two feet eighteen in breadth, and weigh from six to above seven pounds. The female is nearly of the same shape, though less than the male, weighing only between five and six pounds; but her plumage is quite different, the ground colour being of a reddish brown, prettily crossed with waved black lines; and in some specimens the neck, breast, and belly are tinged with ash: the wings are crossed with two bars of white: quills dark: the neck is marked with longitudinal dusky streaks, and the belly is deep brown, spotted obscurely with black. The eider duck lays from three to five large, smooth, pale olive-coloured eggs; these she deposits and conceals in a nest, or bed, made of a great quantity of the soft, warm, elastic down, plucked from her own breast, and sometimes from that of her mate. The ground-work or foundation of the nest is formed of bent-grass, sea-weeds, or such like coarse materials, and it is placed in as sheltered a spot as the bleak and solitary place can afford. In Greenland, Iceland, Spitzbergen, Lapland, and some parts of the coasts of Norway, the eiders flock together, in particular breeding places, in such numbers, and their nests are so close together, that a person in walking along can hardly avoid treading upon them. The natives of these cold climates eagerly watch the time when the first hatchings of the eggs are laid: of these they rob the nest, and also of the more important article, the down with which it is lined, which they carefully gather and carry off. These birds will afterwards strip themselves of their remaining down, and lay a second hatching, of which also they are sometimes robbed: but, it is said, that when this cruel treatment is too often repeated, they leave the place, and return to it no more. The quantity of this valuable commodity, which is thus annually collected in various parts is uncertain. Buffon mentions one particular year, in which the Icelandic company sold as much as amounted to upwards of eight hundred and fifty pounds sterling. This, however, must be only a small portion of the produce, which is all sold by the hardy natives, to stuff the couches of the pampered citizens of more polished nations. The great body of these birds constantly resides in the remote northern, frozen climates, the rigours of which their thick clothing well enables them to bear. They are said to keep together in flocks in the open parts of the sea, fishing and diving very deep in quest of shell-fish and other food, with which the bottom is covered; and when they have satisfied themselves, they retire to the shore, whither they at all times repair for shelter, on the approach of a storm. Other less numerous flocks of the eiders branch out, colonize, and breed further southward in both Europe and America: they are found on the promontories and numerous isles of the coast of Norway, and on those of the northern, and the Hebrides or western isles of Scotland, and also on the Fern isles, on the Northumberland coast, which latter is the only place where they are known to breed in England, and may be said to be their

utmost southern limit in this quarter, although a few solitary instances of single birds being shot further southward along the coast have sometimes happened.

Anas Marila, scaup duck. This species measures, when stretched out, nearly twenty inches in length, and thirty-two in breadth. The bill is broad and flat, more than two inches long, from the corners of the mouth to the tip, and of a fine pale blue or lead colour, with the nail black: irides bright deep yellow: the head and upper half of the neck are black, glossed with green: the lower part of the latter, and the breast, are of a sleek plain black: the throat, rump, upper and under coverts of the tail, and part of the thighs are of the same colour, but dull, and more inclining to brown. The tail, when spread out, is fan-shaped, and consists of fourteen short, brown feathers. The legs are short, toes long, and, as well as the outer or lateral webs of the inner toes, are of a dirty pale blue colour; all the joints and the rest of the webs are dusky. These birds are said to vary greatly in their plumage, as well as size; but those which have come under the author's observation were all nearly alike. The scaup duck, like others of the same genus, quits the rigours of the dreary north in the winter months, and in that season only is met with, in small numbers, on various parts of the British shores.

Anas Clangula, the golden-eye. The weight of this species varies from twenty-six ounces to two pounds. The length is nineteen inches, and the breadth thirty-one. These birds do not congregate in large flocks, nor are they numerous on the British shores, or on the lakes in the interior. They are late in taking their departure northward in the spring. In their flight they make the air whistle with the vigorous quick strokes of their wings; they are excellent divers, and seldom set foot on the shore, upon which, it is said, they walk with great apparent difficulty, and, except in the breeding season, only repair to it for the purpose of taking their repose. The attempts which were made by M. Baillon to domesticate these birds, he informs the Count de Buffon, quite failed of success. See Plate III. Aves, fig. 1 to 5.

ANASARCA, in medicine, a species of dropsy, wherein the skin appears puffed up and swelled, and yields to the impression of the fingers, like dough. See MEDICINE.

ANASTATICA, the *rose of Jericho*, in botany, a genus of the Tetradynamia Siliculosa class of plants, the calyx of which is a deciduous perianthium, consisting of four oval, oblong, concave, erect, and deciduous leaves: its flower consists of four roundish petals, disposed in the form of a cross; and its fruit is a short bilocular pod, containing in each cell a single roundish seed. There are two species; one is found growing naturally on the coast of the Red-sea, in Palestine, and near Cairo, in sandy places. The stalks are ligneous, though the plant is annual. It is preserved in botanic gardens for the variety, and in some curious gardens for the oddness of the plant, which if taken up before it is withered, and kept entire in a dry room, may be long preserved, and after being many years in this situation, if the root is placed in a glass of water a few hours, the buds of the flowers will swell, open, and appear as if newly taken out of the ground. The second species, called the A. syriaca, is a native of Austria, Steria, Carniola, Syria, and Sumatra. These plants, being annual, can be propagated only by seeds, which rarely ripen in England.

ANATOMY is the art of examining animal bodies by dissection. It teaches the structure and functions of these bodies, and shews nearly on what life and health depend. When these are well understood, a great step is made towards the knowledge and cure of diseases.

It is derived from the Greek verb ανατεμνω, I cut up: yet we do not comprehend under it the mere cutting of dead bodies; but every operation by which we endeavour to discover the structure and use of any part of the body.

As every animal body is the subject of anatomy, we divide it into the *human* and *comparative*. The first of these, which is confined to the human body, forms the subject of the present article; the last, which is extended to the whole animal creation, will be considered under the head of COMPARATIVE ANATOMY. The offices or functions of the various parts of the body are the objects of the science of PHYSIOLOGY: to which article the reader is referred for those subjects.

The limits, to which we are confined by the nature of the present work, will prevent us from entering much into the details of the structure and composition of the human body. We shall present the reader with a general sketch of the subject, as being more suited to the space which this article is allowed to occupy. After a cursory view of

the origin and progress of anatomical science, we shall give a general description of the component parts of the human body, and their functions; and proceed in the last place to the more particular enumeration and description of the various organs.

HISTORY OF ANATOMY.

The want of records leaves us in the dark, with regard to the origin of this art; yet it is reasonable to conclude, that, like most other arts, it had no precise beginning. The nature of the thing would not admit of its lying for a time altogether concealed, and of being suddenly brought to light, either by chance, or genius, or industry.

All the studies and arts which are necessary in human life, are so interesting and obvious, that man in every situation has always by instinct and common sense turned his thoughts to them, and made some progress in the cultivation of them. To talk seriously of the invention of agriculture, architecture, astronomy, navigation, mechanics, physic, surgery, or anatomy, by some particular man, or in one particular country, or at a time subsequent to some prior æra, would be to discover great ignorance of human nature. We might just as well suppose, that till a certain period of time, man was without instinctive appetites, and without observation and reflection, and that in a happy hour he found out the art of supporting life by taking food. All such arts, in a less or more cultivated state, were from the beginning, and ever will be found in all parts of the inhabited world.

The first men who lived, must soon have acquired some notions of the structure of their own bodies, particularly of the external parts, and of some even of the internal, such as bones, joints, and sinews; which are exposed to the examination of the senses in the living body.

This rude knowledge was indeed gradually improved by the accidents to which the body is exposed, by the necessities of life, and by the various customs, ceremonies, and superstitions of different nations. Thus, the observance of bodies killed by violence, attention to wounded men, and to many diseases, the various ways of putting criminals to death, the funeral ceremonies, and a variety of such things, must have shewn men, every day, more and more of themselves; especially as curiosity and self-love would urge them powerfully to observation and reflection.

The brute creation having such an affinity to man, in outward form, motions, senses, and ways of life; the generation of the species, and the effect of death upon the body, being observed to be so nearly the same in both, the conclusion was not only obvious, but unavoidable, that their bodies were formed nearly upon the same model. The opportunities of examining the bodies of brutes were so easily procured; indeed so necessarily occurred in the common business of life, that the huntsman in making use of his prey, the priest in sacrificing, the augur in divination, and above all, the butcher, or those who might out of curiosity attend his operations, would have been daily adding to the little stock of anatomical knowledge. Accordingly we find, in fact, that the South-sea islanders, who have been left to their own observation and reasoning, without the assistance of letters, have yet a considerable share of rude or wild anatomical and physiological knowledge. When Omai was in Dr. Hunter's museum, although he could not explain himself intelligibly, it appeared plainly that he knew the principal parts of the body, and something likewise of their uses, and manifested a great curiosity, or desire of having the functions of the internal parts of the body explained to him; particularly the relative functions of the two sexes, which, with him, seemed to be the most interesting object of the human mind. The poems of Homer likewise shew us that many facts were popularly known in his time; he probably possessed the general information on the subject. The following passages display a knowledge of some of the internal parts of the body:

> "Antilochus, as Thoon turn'd him round,
> Transpierc'd his back with a dishonest wound.
> The hollow vein, that to the neck extends,
> Along the chine, his eager jav'lin rends."
> Iliad, b. 13.

The stone, which Diomed threw at Æneas, is said to have broken the acetabulum, and to have torn both the ligaments which connect the thigh in its situation. These particulars are not mentioned in Mr. Pope's translation, we therefore cite the original:

> Τω βαλεν Αινειαο κατ᾽ ισχιον, ενθα τε μηρος
> Ισχιῳ ενϛρεφεται· κοτυλην δε τε μιν καλεουσι·
> Θλασσε δε ὁι κοτυλην, προς δ' ἀμφω ρηξε τενοντε. Il. 5. l. 305.

From the sources which have been just enumerated was derived the anatomical knowledge of early times. This knowledge was general or popular. *Anatomy*, properly so called, viz. the knowledge of the structure of the body, obtained by dissections expressly instituted for that purpose, is of much more recent origin.

Civilization and improvements of every kind would naturally begin in fertile countries and healthful climates, where there would be leisure for reflection, and an appetite for amusement. It seems now to be clearly made out, that writing, and many other useful and ornamental inventions and arts were cultivated in the eastern parts of Asia, long before the earliest times that are treated of by the Greek or other European writers; and that the arts and learning of those eastern people were, in subsequent times, gradually communicated to adjacent countries, especially by the medium of traffic. The customs, superstitions, and climates of eastern countries appear however to have been as unfavourable to practical anatomy, as they were inviting to the study of astronomy, geometry, poetry, and all the softer arts of peace. In those warm climates, animal bodies run so quickly into nauseous putrefaction, that the early inhabitants must have avoided such offensive employments as anatomical inquiries, like their posterity at this day. And, in fact, it does not appear, by the writings of the Grecians, Jews, or Phœnicians, that anatomy was particularly cultivated by any of those nations.

The progress of anatomy in the early ages of the world was more particularly prevented by a very generally prevalent opinion, that the touch of a dead body communicated a moral pollution. When we consider the extent and inveteracy of this prejudice, we shall cease to wonder at the imperfect state of anatomical knowledge in the periods now under review. The practice of embalming the bodies of the dead did not at all reconcile the Egyptians to dissections. The person who made the incision, through which the viscera were removed, immediately ran away, followed by the imprecations and even violence of the by-standers, who considered him to have violated the body of a friend. The ceremonial law of the Jews was very rigorous in this respect. To touch several animals, which they accounted unclean, subjected the person to the necessity of purifications, &c. To touch a dead body made a person unclean for seven days. "Whosoever, (says the Jewish lawgiver) toucheth the body of any man that is dead, and purifieth not himself, defileth the tabernacle of the Lord; and that soul shall be cut off from Israel."

In tracing it backwards in its infancy, we cannot go farther into antiquity than the times of the Grecian philosophers. As an art in the state of some cultivation, it may be said to have been brought forth and bred up among them, as a branch of natural knowledge. We discover in the writings of Plato, that he had paid attention to the organisation and functions of the human body.

Hippocrates, who lived about four hundred years before Christ, and was reckoned the eighteenth in descent from Æsculapius, was the first who separated the professions of philosophy and physic, and devoted himself exclusively to the latter pursuit. He is generally supposed to be the first who wrote upon anatomy. After the restoration of Greek learning, in the fifteenth century, it was so fashionable, for two hundred years together, to extol the knowledge of the ancients in anatomy, as in other things, that anatomists seem to have made it a point of emulation, who should be most lavish in their praise; some from a diffidence in themselves; others through the love of detracting from the merit of contemporaries; many from having laboriously studied ancient learning, and having become enthusiasts in Greek literature; but more, perhaps, because it was the fashionable turn of the times, and was held up as the mark of good education and fine taste. If, however, we read the works of Hippocrates with impartiality, and apply his accounts of the parts, to what we now know of the human body, we must allow his descriptions to be imperfect, incorrect, sometimes extravagant, and often unintelligible, that of the bones only excepted.

From Hippocrates to Galen, who flourished towards the end of the second century, in the decline of the Roman empire, that is, in the space of six hundred years, anatomy was greatly improved; the philosophers still considering it as a most curious and interesting branch of natural knowledge, and the physicians, as a principal foundation of their art. Both of them, in that interval of time, contributed daily to the common stock, by more accurate and extended observations, and by the lights of improving philosophy.

Aristotle, a disciple of Plato, and preceptor of Alexander the Great, is no less entitled to immortality for his immense labours in natural history and comparative anatomy, than as the founder of the Peripatetic philosophy, which for two thousand years held undisputed sway over the whole learned world. He had formed the most enlarged design which perhaps was ever conceived by any man; no less than that of a general and detailed history of all nature, a plan by far too vast for the short life of an individual. The love of science, which distinguished Alexander no less than his ambition and thirst for glory, led him to encourage and assist the plans of Aristotle in a manner worthy of so great a prince, of so exalted a genius, and of such magnificent designs. The sum of money which he was thereby enabled to devote to his works on natural history would be almost incredible, did we not consider the traits of greatness which mark every action of Alexander, and were not the circumstance stated by writers of unexceptionable authority. Athenæus, Pliny, and Ælian concur in representing it at between one and two hundred thousand pounds.

Shortly after the foundation of Alexandria, a celebrated school was established there, to which the Greeks and other foreigners resorted for instruction, and where physic and every branch of natural knowledge were taught in the greatest perfection. Herophilus and Erasistratus, two anatomists of this school, are particularly celebrated in the history of anatomy. They seem to be the first who dissected the human body. At least in the time of Aristotle, who preceded these anatomists by a very short interval, brutes only had been anatomised. It might have been expected that the practice of embalming would afford favourable opportunities of anatomical investigation, but the rude manner in which the body was prepared, and the dread of pollution, prevented all instructive examination. The progress of the science required that anatomists should have subjects, on which careful and deliberate dissection might be prosecuted without fear of interruption. This benefit was obtained through the taste which the princes of that time displayed for the arts and sciences. The Ptolemies inherited, with their share of the empire of Alexander, the love of science, which shone so conspicuously in that monarch. Ptolemy Philadelphus invited to his capital the greatest men of the age; and, by collecting books from all parts, at an immense expense, laid the foundation of the magnificent Alexandrian library. This king and his predecessor seem to have overcome the religious scruples which forbade the touch of the dead body, and gave up to the physicians the bodies of those who had forfeited their lives to the law. Nay, if the testimony of several authors may be believed, Herophilus and Erasistratus dissected several unfortunate criminals alive. There is, however, something in this practice so repugnant to every feeling of humanity, that we ought probably to consider it only as an exaggerated report of the novel practice of dissecting the human subject. The writings of these anatomists have not descended to us: our knowledge of their progress in anatomy is derived only from a few extracts and notices which occur in the works of Galen; but these prove them to have made great advances in the knowledge of the structure of the human body.

The Romans, in prosecuting their schemes of universal conquest and dominion, soon became acquainted with the Greeks, and the intercourse of the two nations was constantly increasing. Thus the arts, the philosophy, and the manners of the Greeks were introduced into Italy. Military glory and patriotism, which had formerly been the ruling passions of the Roman people, now gave way in some degree to the soft arts of peace. The leading men of the Roman republic sought the company and conversation of the learned Greeks; thus literature and philosophy were transported from the Greeks to the Romans, and gave rise to the taste and elegance of the Augustan age. In this way did conquered Greece triumph over the unpolished roughness of her conquerors.

Græcia capta ferum victorem cepit, et artes
Intulit agresti Latio.

Although Rome produced orators, poets, philosophers, and historians, which may be brought into competition with those of the Greeks, to the eternal disgrace of their empire it must be allowed, that their history is hardly embellished with the name of a single Roman who was great in science or art, in painting or sculpture, in physic, or in any branch of natural knowledge. We cannot therefore introduce one Roman into the history of anatomy. Pliny and Celsus were mere compilers from the Greeks. We may account for this apparent neglect of anatomy among the Romans, as well indeed as for its

slow progress among the Greeks, from some of their religious tenets, as well as from the notion already mentioned, of pollution being communicated by touching a dead body. It was believed, that the souls of the unburied were not admitted into the abodes of the dead, or, at least, that they wandered for a hundred years along the river Styx, before they were allowed to cross it. Whoever saw a dead body was obliged to throw some earth upon it, and if he neglected to do so, he was obliged to expiate his crime by sacrificing to Ceres. It was unlawful for the pontifex maximus not only to touch a dead body, but even to look at it; and the flamen of Jupiter might not even go where there was a grave. Persons who had attended a funeral were purified by a sprinkling of water from the hands of the priest, and the house was purified in the same manner. If any one (says Euripides, in Iphigenia) pollutes his hands by a murder, by touching a corpse, or a woman who has lain in, the altars of God are interdicted to him.

There was no anatomist or physiologist of sufficient reputation to attract our notice from the times of Herophilus and Erasistratus to the age of Galen. This illustrious character was born at Pergamus, in Asia Minor, about the 130th year of the Christian æra. No expense was spared in his education; after the completion of which he visited all the most famous schools of philosophy which then existed; and afterwards resided chiefly at Rome, in the service of the emperors of that time.

To all the knowledge which could be derived from the writing of Hippocrates, and the philosophical schools of the time, Galen added the results of his own labours and observation, and compiled from these sources a voluminous system of medicine. It is generally considered, that the subjects of his anatomical labours were chiefly brutes; and it is manifest from several passages, that his descriptions are drawn from monkeys. Indeed, he never expressly states that he has dissected the human subject, although he says he has seen human skeletons. He must be accounted the first who placed anatomical science on a respectable footing; and deserves our gratitude for this, that he was the only source of anatomical knowledge for about ten centuries. The science declined with Galen; his successors were contented with copying him; and there is no proof of a dissection of any human body from Galen to the Emperor Frederick II. We may observe, that when any man arrives at the reputation of having carried his art far beyond all others, it seems to throw the rest of the world into a kind of despair. Hopeless of being able to improve their art still further, they do nothing. The great man, who was at first only respectable, grows every day into higher credit, till at length he is deified, and every page of his writings becomes sacred and infallible. This was actually the fortune of Aristotle in philosophy, and of Galen in anatomy, for many ages; and such respect shewn to any man, in any age, must always be a mark of declining science.

Anatomy experienced the same fate as learning in general on the decline and fall of the Roman empire. The moral and intellectual character of the Romans had been much debased in the later ages of the empire. Philosophy and science were manifestly degenerating, and their place was supplied by a debased and corrupted theology. The successive irruptions of the northern barbarians accelerated the approaching ruin. The great inundation of the Goths into Italy, in the fifth century, extinguished with the Roman empire its laws, manners, and learning, and plunged the world into the depths of ignorance and superstition. The succeeding ten centuries, which have received the appellation of the dark ages of the world, present a melancholy picture to the philosophic observer of human nature: a barren and dreary waste, not enlivened by a single trace of cultivation.

The followers of the Arabian prophet dissipated the little remains of learning that were left in Asia and Egypt. A contempt of all human knowledge, and the religious obligation of extending the Mahometan faith by means of the sword, made these ignorant barbarians the most dangerous and destructive foes to science and the arts. The city of Alexandria, the school of which had been the resort of the learned for centuries, was taken in the year 640 by Amrou, the general of the Caliph Omar; the celebrated library was burned, with the exception of those books which related to medicine, which the love of life induced the Arabians to spare.

When the Saracens were established in their new conquests, they began to discern the utility of learning in the arts and sciences, and particularly in physic. Mahomet had made it death for any Mussulman to learn the liberal arts: this prohibition was gradually neglected, and many of the caliphs distinguished themselves by their love of

letters, and the munificent institutions which they founded for the propagation of learning. The Greek authors were collected, translated, and commented on; but there was no improvement nor extension of science made. In anatomy the Arabians went no further than Galen, the perusal of whose works supplied the place of dissection. They were prevented from touching the dead by their tenets respecting uncleanness and pollution, which they had derived from the Jews.

The Arabian empire in the east was overturned by the Turks, who, still more barbarous and illiterate than the Saracens, carried ignorance and oppression wherever they directed their footsteps. They soon destroyed all the institutions which the Saracens had formed for the propagation of science, and threatened Constantinople itself, which still retained the faint and almost dying embers of Greek knowledge. This city was taken and sacked in the middle of the fifteenth century; and the learned Greeks fled for safety to the western nations of Europe, bringing with them the Grecian authors on medicine, and translating them; which works the invention of printing, that happened about the same time, greatly contributed to disperse throughout Europe. People had now an opportunity of becoming acquainted with the writings of Galen and the ancients, and, by these means, of arriving at the source of that knowledge which they had hitherto obtained only through the channel of the Arabian physicians. The superiority of the former was soon discovered, and the opinions of the Grecian writers were considered, even in anatomy, as unimpeachable.

For the restoration of anatomy, as well as that of science in general, we are indebted to the Italians. But the first men who signalized themselves in this path partook of that blind reverence for the works of Galen which had reigned universally in medicine since his death, and which concurred with the universally prevailing prejudices of those times concerning the violation of the dead to obstruct all advancement of the science. As an instance of the latter circumstance, we may mention a decree of Pope Boniface VIII. prohibiting the boiling and preparing of bones, which put a stop to the researches of Mundinus.

Among the circumstances which contributed to the restoration of anatomy is to be reckoned the assistance which it derived from the great painters and sculptors of this age. A knowledge of the anatomy of the surface of the body, at least, is essential to the prosecution of these arts. Michael Angelo dissected men and animals, in order to learn the muscles which lie under the skin. A collection of anatomical drawings made by Leonardo da Vinci at this period is still extant, and, with subjoined explanations, are found in the library of the king. Dr. Hunter bears witness to the minute and accurate knowledge which these sketches discover, and does not hesitate in considering Leonardo as the best anatomist of that time.

About the middle of the sixteenth century the great Vesalius appeared. He was born at Brussels, and studied successively at the different universities of France and Italy. Thus he acquired all the knowledge of antiquity. Not contented with this, he took every opportunity of examining the human body, and followed the army of the Emperor Charles V. into France for that purpose. Vesalius was the first who maintained that dissection was the proper way of learning anatomy, in opposition to the study of the works of Galen. His extensive researches into the structure of man and animals led him to detect the errors of Galen, which he freely exposed, shewing from many parts of his works, that this great man had described the human body from the dissection of brutes. This conduct, which should have excited the admiration and esteem of his contemporaries, served only to rouse in their minds the base and sordid passions of jealousy and envy. Galen had held an undisputed sway over the minds of men for many centuries. His works were regarded as the only source of anatomical knowledge, and his opinion on medical subjects, like that of Aristotle in philosophy, was resorted to in all disputes as final and decisive proof. The first man who penetrated this intellectual mist, and erected the standard of reason and truth, in opposition to that of prejudice and authority, might naturally expect to encounter the opposition of those who had been contented to go on in the beaten track. The anatomists who had always held up Galen in their lectures as the source of all information, were indignant that his faults should be discovered and laid open by so young a man as Vesalius. The controversies which arose from this cause were favourable to the progress of anatomy; as the several disputants were obliged to confirm their own opinions, or invalidate those of their opponents, by arguments drawn from dissection.

Vesalius published, at the age of 25, his

grand work on the structure of the human body, with numerous elegant figures, supposed to have been drawn by the celebrated Titian. This work contains such a mass of new information, that it may justly be considered as forming an æra in the history of anatomy. We cannot help being surprised, that so young a man could have investigated the subject so deeply, at a time when dissection was esteemed sacrilegious, and was therefore carried on secretly with great danger and difficulty. The great reputation of Vesalius procured for him the esteem and confidence of Charles V. who made him his physician, and kept him about his person in all his expeditions. His zeal for science proved the cause of his death: for having opened a person too soon, the heart was seen to palpitate. He was condemned to perform a pilgrimage to Jerusalem; and as he was returning to take the place of anatomical professor at Venice, he was shipwrecked on the island of Zante, and perished of hunger. It would be unjust to pass over unnoticed the names of Fallopius, and of Eustachius, who were contemporary with Vesalius, and contributed greatly to the advancement of anatomy. The anatomical plates drawn and engraved by the latter are executed with an accuracy which cannot fail to excite surprise, even in an anatomist of the present day.

From the time of Vesalius, the study of anatomy gradually diffused itself over Europe; insomuch that for the last hundred and fifty years it has been daily improving by the labour of many professed anatomists in almost every country of Europe.

In the year 1628, our immortal countryman Harvey published his discovery of the circulation of the blood. It was by far the most important step that has been made in the knowledge of animal bodies in any age. It not only reflected useful lights upon what had been already found out in anatomy, but also pointed out the means of further investigation, and accordingly we see that, from Harvey to the present time, anatomy has been so much improved, that we may reasonably question if the ancients have been further outdone by the moderns in any other branch of knowledge. From one day to another there has been a constant succession of discoveries, relating either to the structure or functions of our body; and new anatomical processes, both of investigation and demonstration have been daily invented. Many parts of the body, which were not known in Harvey's time, have since then been brought to light; and of those, which were known, the internal composition and functions remained unexplained; and indeed must have remained inexplicable, without the knowledge of the circulation.

The principal facts relating to this subject were known before the time of Harvey: it remained for him to reject the specious conjectures then maintained concerning the blood's motion, and to examine the truth of those facts, which were then known, and by experiments to discover those which remained to be detected. This he did, and thereby rendered his name immortal.

It seems proper in this place to review the several steps which were made in the investigation of this important subject. Hippocrates believed that all the vessels communicated with each other, and that the blood underwent a kind of flux and reflux from and to the heart, like the ebbing and flowing of the sea. The anatomists at Alexandria adopted a wrong but ingenious opinion; as they found the arteries empty, and the veins containing blood, in their dissections, they imagined that the former were tubes for the distribution of air, and gave them that name, which they have retained ever since; and that the veins were the only channels for the blood. Galen ascertained that the blood flowed both by the arteries and veins, though he knew not then its natural course. On the revival of anatomy in Europe, the pulmonary circulation was known to many eminent men. This was certainly the case with Servetus, who fell a sacrifice, on account of his religious opinions, to the savage bigotry and intolerance of Calvin. Fabricius ab Aquapendente, the preceptor of our famous Harvey, particularly described the valves of the veins, the mechanism of which would absolutely prevent the blood from flowing in those vessels towards the extremities. When Harvey returned from his studies in Italy, his attention being excited to the subject, he began those experiments, by which he learned and demonstrated the fact of the circulation. Harvey's first proposition of the subject impresses conviction so strongly on the mind, that we are left in perfect astonishment, how a circumstance so luminously evident should have remained so long unobserved. It must be granted, that the heart projects about two ounces of blood into the arteries at every pulse; what then, it may be asked, becomes of this large quantity of blood unless it circulates? It must be granted that the heart receives

that quantity prior to every pulse. From whence is it received, unless the blood circulates? Harvey tied an artery, and the corresponding vein received no blood; he tied a vein, and all its branches, and those of the corresponding artery, were choaked with blood, even to the entire obstruction of circulation and motion. But Harvey was not acquainted with the direct communication that exists between these vessels. He imagined that the blood transuded from the arteries into the veins through a spongy substance. Much yet remained to be ascertained by microscopical observations, and subtile anatomical injections and dissections.

As opportunities of dissection became more numerous, the defects of the old writers in anatomy were discovered. Ingenious men, having gone through their education, determined to consult nature for themselves. It is not to be wondered at that errors and deficiencies in anatomy were found in every page of the works of Galen, to say nothing of Hippocrates, since the human body, in his time, could not be consulted for information. The authority of the Greek writers on these subjects was quickly demolished, and anatomy began to be taught from the subject itself. We must not omit the influence, which the writings of our immortal countryman Bacon had on the prosecution of natural knowledge, and in every species of reasoning. The philosophy of Aristotle was driven from the pre-eminent station, which it had so long occupied, to make room for the only solid and secure method, of observation, experiment and induction. At this time the Academy del Cimento arose in Italy, the Royal Society in London, and the Royal Academy in Paris. From this period, the important doctrine of rejecting all hypothesis, or general knowledge, till a sufficient number of facts shall have been ascertained, by careful observation and judicious experiments, has been every day growing into more credit. The anatomists and physiologists of these times distinguished themselves by a patient observation of nature itself, and an accurate account of the phænomena which they observed.

After the discovery and knowledge of the circulation of the blood, the next question would naturally be about the passage and route of the nutritious part of the food, or chyle, from the bowels to the blood-vessels. The name of Aselli, an Italian physician, is rendered illustrious by the discovery of the vessels which carry the chyle from the intestines. He observed them full of a white liquor on the mesentery of living animals, and from this circumstance called them milky or lacteal vessels. For many years the anatomists in all parts of Europe were daily opening living animals, either to see the lacteals, or to observe the phænomena of the circulation. In making an experiment of this kind, Pecquet in France was fortunate enough to discover the thoracic duct, or common trunk of all the lacteals, which conveys the chyle into the subclavian vein. And now the lacteals having been traced from the intestines to the thoracic duct, and that duct having been traced to its termination in a blood-vessel, the passage of the chyle was completely made out. The discovery of the absorbent vessels in other parts of the body, where they are known by the name of lymphatics, from the transparent colour of their contents, very soon followed that of the lacteals and thoracic duct. Rudbek, a Swede, is generally allowed to have been the first who discovered these vessels; but this honour was disputed with him by Bartholin, a learned Dane. By these vessels the old particles of our bodies, which are no longer fit to remain in it, are removed and conveyed into the blood, to be eliminated by the excretory organs.

Leeuenhoeck took up the subject of anatomical inquiry, where others had left it. He investigated the minute structure of the body by the help of magnifying glasses; and was thereby enabled to demonstrate the circulation of the blood in the pellucid parts of living animals; the red globules of the blood, and the animalcula of the semen were first observed by this anatomist. Malpighi also directed his attention chiefly to the development of minute structure, as that of the glands or secretory organs of the body.

About this time anatomy made two great steps, by the invention of injections, and the method of making anatomical preparations. For these we are indebted to the Dutch, particularly Swammerdam and Ruysch. The anatomists of former ages had no other knowledge of the blood-vessels, than what they could collect from laborious dissections, and from examining the smaller branches of them upon some lucky occasion, when they were found more than commonly loaded with red blood. But filling the vascular system with a bright coloured wax enables us to trace the large vessels with great ease, renders the smaller much more conspicuous,

and makes thousands of the very minute ones visible, which from their delicacy, and the transparency of their natural contents, are otherwise imperceptible. The modern art of corroding the fleshy parts with a menstruum, and of leaving the moulded wax entire, is so exceedingly useful, and at the same time so ornamental, that it does great honour to the ingenious inventor, Dr. Nichols. The method of casting figures in wax, plaister, or lead is also a great acquisition to anatomy, as it enables us to preserve a very perfect likeness of such subjects as we but seldom meet with, or cannot well preserve in a natural state. The modern improved methods of preserving animal bodies, or parts of them, in spirits, has been of the greatest service to anatomy; especially in saving the time and labour of the anatomist, in the nicer dissections of the small parts of the body. For now, whatever he has prepared with care, he can preserve, and the object is ready to be seen at any time. And, in the same manner, he can preserve anatomical curiosities and rarities of every kind; such as parts that are uncommonly formed; parts that are diseased; the parts of the pregnant uterus, and its contents. Large collections of such curiosities, which modern anatomists are striving every where to procure, are of infinite service to the art; especially in the hands of teachers. They give students clear ideas about many things, which it is very essential to know, and yet which it is impossible that a teacher should be able to shew otherwise, were he ever so well supplied with fresh subjects.

When anatomy had thus become a clear and distinct science, it was inculcated and taught, in the different nations of Europe, by numerous professors, with a zeal and industry highly honourable to themselves, and useful to mankind. As the prejudices of mankind respecting dissection have in a great measure subsided, the difficulties which formerly obstructed anatomical researches have mostly disappeared, and a sufficient quantity of subjects for anatomical purposes can generally be procured. In most, perhaps in all, the countries of the continent of Europe, the government has provided for the wants of anatomists in this particular. In England, however, it still remains a matter of considerable difficulty and expense to procure the means of instruction in practical anatomy; and accordingly while foreigners have been enriching science with many splendid works, the name of one Englishman cannot for many years past be recorded in the annals of anatomy. We wish we could announce to our readers any prospect of a change in this respect; but here literature and science are left to themselves, and must advance unaided by the patronage of government, or not advance at all.

It would occupy us too long to detail the labours and discoveries of all the eminent men, who have immortalized themselves in anatomy during the last century. We may state generally, that every part of the human body has been most thoroughly and minutely examined and described; and accurate and elegant engravings have appeared of every part. So that a student in these days possesses every facility for the prosecution of his anatomical labours. The bones and muscles have been most elegantly represented and described by Albinus, Cheselden, Sue, and Cowper. The vascular system has been illustrated by a splendid work of the immortal Haller. Walker and Meckel of Berlin, and Scarpa at Pavia, have bestowed equal, or even superior diligence in tracing the distribution of the most important nerves, and representing them in faithful engravings. Mr. Cruikshank distinguished himself by an excellent book on the absorbing system; and Mascagni has lately given to the public a most elaborate account of the absorbing vessels, with very splendid plates. Dr. Hunter, to whom anatomy owes more in this country, than to any individual, has published a complete history, with beautiful explanatory engravings, of the growth of the human ovum, and of the changes which the uterus undergoes after the ovum has been received into its cavity. His brother, Mr. John Hunter, also demands mention in this place, as an accurate and minute dissector, and a patient experimentalist. He surveyed in his researches the whole field of animated nature; and greatly promoted the science of physiology. He formed also the grandest and most beautiful anatomical cabinet in Europe; and this precious treasure has now passed into the hands of the Royal College of Surgeons in London. The structure of the brain has been represented with unrivalled elegance by Vicq D'Azyr, a French anatomist, in a folio volume of coloured plates, which we hesitate not to applaud as a chef d'œuvre of anatomical science, and a most splendid monument of the arts. Some parts of this most important organ, have also been illustrated by the la-

bours of Soemmerring, who still prosecutes the study of anatomy with unwearied industry. We have lately from his hands, two most finished productions in every respect, on the anatomy of the eye and ear. It would be unjust not to enumerate with a due tribute of applause, the labours of Zinn, Cassebohm, and Scarpa, on the same subjects.

Morgagni, who taught anatomy in Padua, published a work of great utility on morbid anatomy. Dr. Baillie has of late in this country prosecuted the same subject, though in a different manner. He has published a book on the morbid anatomy of the body, and has illustrated his descriptions by a collection of the most elegant, expressive, and accurate plates.

Winslow, Sabatier, and Bichat, are the authors of the most approved anatomical systems in France, and Soemmerring and Hildebrandt in Germany. We regret that it is not in our power to mention any correct and complete system by an English writer. The imperfect and contemptible ephemeral productions published under the auspices of booksellers, cannot have a place in this enumeration.

UTILITY OF ANATOMY.

Astronomy and anatomy, as Fontenelle observes, are the studies which present us with the most striking view of the two greatest attributes of the Supreme Being. The first of these fills the mind with the idea of his immensity, in the largeness, distances, and number of the heavenly bodies; the last astonishes with his intelligence and art in the variety and delicacy of animal mechanism.

The human body has been commonly enough known by the name of microcosmus; as if it did not differ so much from the universal system of nature, in the symmetry and number of its parts, as in their size.

Galen's excellent treatise on the use of the parts was composed as a prose hymn to the Creator; and abounds with as irresistible proofs of a Supreme Cause, and governing Providence, as we find in modern physico-theology. And Cicero dwells more on the structure and economy of animals, than on all the productions of nature besides, when he wants to prove the existence of the Gods from the order and beauty of the universe. He there takes a survey of the body of man in a most elegant synopsis of anatomy, and concludes thus; "Quibus rebus expositis, satis docuisse videor, hominis natura quanto omnes anteiret animales. Ex quo debet intelligi, nec figuram situmque membrorum, nec ingenii mentisque vim talem effici potuisse fortuna." The satisfaction of mind which arises from the study of anatomy, and the influence which it must naturally have on our minds as philosophers, cannot be better conveyed than by the following passage from the same author; "Quæ contuens animus, accepit ab his cognitionem deorum, ex qua oritur pietas: cui conjuncta justitia est, reliquæque virtutes; ex quibus vita beata exsistit, par et similis deorum, nulla alia re nisi immortalitate, quæ nihil ad bene vivendum pertinet, cedens cœlestibus."

It would be endless to quote the animated passages of this sort, which are to be found in the physicians, philosophers, and theologists, who have considered the structure and functions of animals, with a view towards the Creator. It is a view that must strike us with the most awful conviction. Who can know and consider the thousand evident proofs of the astonishing art of the Creator, in forming and sustaining an animal body such as ours, without feeling the most pleasing enthusiasm? Can we seriously reflect upon this awful subject without being almost lost in adoration? Without longing for another life after this, in which we may be gratified with the highest enjoyment which our faculties and nature seem capable of, the seeing and comprehending the whole plan of the Creator, in forming the universe, and directing its operations.

In the excellent work of Archdeacon Paley, on natural theology, this view of the subject is most ably explained and illustrated; and the subject is pursued through all its details. We strongly recommend this work, as exhibiting in a popular form a very interesting view of the structure and functions of animal bodies; and we subjoin the following extract as a very successful application of the argument.

"It has been said, that a man cannot lift his hand to his head without finding enough to convince him of the existence of a God. And it is well said; for he has only to reflect, familiar as this action is, and simple as it seems to be, how many things are requisite for the performing of it: how many things which we understand, to say nothing of many more, probably, which we do not; viz. first, a long, hard, strong cylinder to give to the arm its firmness and tension; but which, being rigid, and, in its substance

inflexible, can only turn upon joints: secondly, therefore, joints for this purpose, one at the shoulder to raise the arm, another at the elbow to bend it: these joints continually fed with a soft mucilage, to make the parts slide easily upon one another, and holden together by strong braces, to keep them in their position: then, thirdly, strings and wires, *i. e.* muscles and tendons, artificially inserted for the purpose of drawing the bones in the directions in which the joints allow them to move. Hitherto, we seem to understand the mechanism pretty well; and understanding this, we possess enough for our conclusion: nevertheless we have hitherto only a machine standing still; a dead organization—an apparatus. To put the system in a state of activity; to set it at work; a further provision is necessary, *viz.* a communication with the brain by means of nerves. We know the existence of this communication, because we can see the communicating threads, and can trace them to the brain; its necessity we also know, because if the thread be cut, if the communication be intercepted, the muscle becomes paralytic: but beyond this we know little; the organization being too minute and subtle for our inspection.

"To what has been enumerated, as officiating in the single act of a man's raising his hand to his head, must be added likewise all that is necessary, and all that contributes to the growth, nourishment, and sustentation of the limb, the repair of its waste, the preservation of its health: such as the circulation of the blood through every part of it; its lymphatics, exhalants, absorbents; its excretions and integuments. All these share in the result; join in the effect; and how all these, or any of them, come together without a designing, disposing intelligence, it is impossible to conceive."

But the more immediate purposes of anatomy concern those who are to be the guardians of health; as this study is necessary to lay a foundation for all the branches of medicine.

The more we know of our fabric, the more reason we have to believe, that if our senses were more acute, and our judgment more enlarged, we should be able to trace many springs of life, which are now hidden from us; by the same sagacity we should discover the true causes and nature of diseases; and thereby be enabled to restore the health of many, who are now, from our more confined knowledge, said to labour under incurable disorders. By such an intimate acquaintance with the economy of our bodies, we should discover even the seeds of diseases; and destroy them, before they had taken root in the constitution.

This, indeed, is a pitch of knowledge, which we must not expect to attain. But, surely, we may go some way; and, therefore, let us endeavour to go as far as we can. And if we consider that health and disease are the opposites of each other, there can be no doubt, that the study of the natural state of the body, which constitutes the one, must be the direct road to the knowledge of the other. What has been said of the usefulness of anatomy in physic, will only be called in question by the more illiterate empirics among physicians. They would discourage others from the pursuit of knowledge, which they have not themselves, and which, therefore, they cannot know the value of; and tell us that a little of anatomy is enough for a physician.

That anatomy is the very basis of surgery, every body allows. It is dissection alone that can teach us where we may cut the living body with freedom and dispatch; where we may venture with great circumspection and delicacy; and where we must not, upon any account, attempt it. This informs the head, gives dexterity to the hand, and familiarizes the heart with a sort of necessary inhumanity, the use of cutting instruments upon our fellow creatures.

Were it possible to doubt of the advantages which arise in surgery, from a knowledge of anatomy, we might have ample conviction by comparing the present practice with that of the ancients: and upon tracing the improvements which have been made in later times, they would be found, generally, to have sprung from a more accurate knowledge of the parts concerned. In the hands of a good anatomist, surgery is a salutary, a divine art; but, when practised by men who know not the structure of the human body, it often becomes barbarous and criminal.

The comparison of a physician to a general, is both rational and instructive. The human body under a disease, is the country which labours under a civil war or an invasion. The physician is, or should be, the dictator or general, who is to take the command, and to direct all the necessary operations. To do his duty with full advantage, a general, besides other acquirements, useful in his profession, must make himself master of the anatomy and physiology, as we

may call it, of the country. He may be said to be master of the anatomy of the country, when he knows the figure, dimension, situation, and connection, of all the principal constituent parts; such as the lakes, rivers, marshes, mountains, precipices, plains, woods, roads, passes, fords, towns, fortifications, &c. By the physiology of the country, which he ought likewise to understand, is meant all the variety of active influence which is produced by the inhabitants. If the general be well instructed in all these points, he will find a hundred occasions of drawing advantages from them; and without such knowledge, he will be for ever exposed to some fatal blunder.

GENERAL ACCOUNT OF THE COMPOSITION OF THE BODY.

After having considered the rise and progress of anatomy; the various discoveries that have been made in it from time to time; the great number of diligent observers who have applied themselves to this art; and, the importance of the study, not only for the prevention and cure of diseases, but in furnishing the liveliest proofs of divine wisdom; the following questions seem naturally to arise. For what purpose is there such a variety of parts in the human body? Why such a complication of nice and tender machinery? Why was there not rather a more simple, less delicate, and less expensive frame?

That beginners in the study of anatomy may acquire a satisfactory, general, idea of these subjects, we shall furnish them with clear answers to all such questions. Let us then, in our imagination, make a man: in other words, let us suppose that the mind, or immaterial part, is to be placed in a corporeal fabric, to hold a correspondence with other material beings, by the intervention of the body; and then consider, *a priori*, what will be wanted for her accommodation. In this inquiry we shall plainly see the necessity, or advantage, and therefore the final cause of most of the parts, which we actually find in the human body. And if we consider, that in order to answer some of the requisites, human art and invention would be very insufficient; we need not be surprised if we meet with some parts of the body the use of which we cannot yet make out; and with some operations or functions which we cannot explain. We can see and comprehend that the whole bears the strongest marks of excelling wisdom and ingenuity: but the imperfect senses and capacity of man cannot pretend to reach every part of a machine, which nothing less than the intelligence and power of the Supreme Being could contrive and execute.

To proceed then; in the first place, the mind, the thinking immaterial agent, must be provided with a place of immediate residence, which shall have all the requisites for the union of spirit and body; accordingly she is provided with the brain, where she dwells as governor and superintendant of the whole fabric.

In the second place, as she is to hold a correspondence with all the material beings which surround her, she must be supplied with organs fitted to receive the different kinds of impressions that they will make. In fact, therefore, we see that she is provided with the organs of sense, as we call them: the eye is adapted to light, the ear to sound, the nose to smell, the mouth to taste, and the skin to touch.

In the third place, she must be provided with organs of communication between herself, in the brain, and those organs of sense, to give her information of all the impressions that are made upon them: and she must have organs between herself, in the brain, and every other part of the body, fitted to convey her commands and influence over the whole. For these purposes the nerves are actually given. They are chords, which rise from the brain, the immediate residence of the mind, and disperse themselves in branches through all parts of the body. They are intended to be occasional monitors against all such impressions as might endanger the well-being of the whole, or of any particular part, which vindicates the Creator of all things in having actually subjected us to those many disagreeable and painful sensations which we are exposed to from a thousand accidents in life.

Further, the mind, in this corporeal system, must be endued with the power of moving from place to place, that she may have intercourse with a variety of objects; that she may fly from such as are disagreeable, dangerous, or hurtful, and pursue such as are pleasant or useful to her. And accordingly she is furnished with limbs, and with muscles and tendons, the instruments of motion, which are found in every part of the fabric where motion is necessary.

But to support, to give firmness and shape to the fabric, to keep the softer parts in their proper places, to give fixed points and the proper direction to its motions, as well as to protect some of the more impor-

tant and tender organs from external injuries, there must be some firm prop-work interwoven through the whole. And, in fact, for such purposes the bones are given.

The prop-work must not be made into one rigid fabric, for that would prevent motion. Therefore there are a number of bones. These pieces must all be firmly bound together to prevent their dislocation, and this end is perfectly well answered by the ligaments. The extremities of these bony pieces, where they move and rub upon one another, must have smooth and slippery surfaces, for easy motion. This is most happily provided for by the cartilages and mucus of the joints.

The interstices of all these parts must be filled up with some soft and ductile matter, which shall keep them in their places, unite them, and at the same time allow them to move a little upon one another. This end is accordingly answered by the cellular membrane, or adipous substance.

There must be an outward covering over the whole apparatus, both to give it a firm compactness, and to defend it from a thousand injuries, which, in fact, are the very purposes of the skin, and other integuments.

As she is made for society and intercourse with beings of her own kind, she must be endued with powers of expressing and communicating her thoughts by some sensible marks or signs, which shall be both easy to herself, and admit of great variety. Hence she is provided with the organs and faculty of speech, by which she can throw out signs with amazing facility, and vary them without end.

Thus we have built up an animal body which would seem to be pretty complete; but we have not yet made any provision for its duration: and, as it is the nature of matter to be altered and worked upon by matter, so in a very little time such a living creature must be destroyed, if there is no provision for repairing the injuries which she must commit upon herself, and the injuries which she must be exposed to from without. Therefore a treasure of blood is actually provided in the heart and vascular system, full of nutritious and healing particles, fluid enough to penetrate into the minutest parts of the animal. Impelled by the heart, and conveyed by the arteries, it washes every part, builds up what was broken down, and sweeps away the old and useless materials.

Hence we see the necessity or advantage of the heart and arterial system: the overplus of this blood, beyond what was required to repair the present damages of the machine, must not be lost, but should be returned again to the heart; and for this purpose the venal system is actually provided. These requisites in the animal explain, *a priori*, the circulation of the blood.

The old materials, which are become useless, and are swept off by the current of blood, must be separated and thrown out of the system. Therefore glands, the organs of secretion, are given, for straining whatever is redundant, vapid, or noxious, from the mass of blood; and when strained, it is thrown out by excretories.

Now, as the fabric must be constantly wearing, the reparation must be carried on without intermission, and the strainers must always be employed: therefore there is actually a perpetual circulation of the blood, and the secretions are always going on.

But even all this provision would not be sufficient; for that store of blood would soon be consumed, and the fabric would break down, if there were not a provision made for fresh supplies. These we observe, in fact, are profusely scattered round her in the animal and vegetable kingdoms; and she is provided with hands, the finest instruments that could have been contrived, for gathering them, and for preparing them in a variety of different ways for the mouth. These supplies, which we call food, must be considerably changed; they must be converted into blood: therefore she is provided with teeth for cutting and bruising the food, and with a stomach for melting it down; in short, with all the organs subservient to digestion. The finer parts of the aliments only can be useful in the constitution: these must be taken up, and conveyed into the blood, and the dregs must be thrown off. With this view the intestinal canal is constructed. It separates the nutritious part, which we call chyle, to be conveyed into the blood by the system of absorbent vessels; and the feces pass downwards, to be conducted out of the body.

Now we have got our animal, not only furnished with what is wanted for its immediate existence, but also with the power of spinning out that existence to an indefinite length of time. But its duration, we may presume, must necessarily be limited: for as it is nourished, grows, and is raised up to its full strength and perfection, so it must, in time, in common with all material things, begin to decay, and then hurry on to final ruin. Hence we see the necessity of a

scheme for renovation. Accordingly a wise Providence, to perpetuate as well as to preserve his work, besides giving a strong appetite for life and self-preservation, has made animals male and female, and given them such organs and passions as will secure the propagation of the species to the end of the world.

Thus we see, that by the very imperfect survey which human reason is able to take of this subject, the animal man must necessarily be complex in his corporeal system, and in its operations. He must have one great and general system, the vascular, branching through the whole for circulation: another, the nervous, with its appendages, the organs of sense, for every kind of feeling: and a third, for the union and connection of all those parts.

Besides these primary and general systems, he requires others, which may be more local or confined: one for strength, support, and protection; the bony compages: another for the requisite motions of the parts among themselves, as well as for moving from place to place; the muscular part of the body: another to prepare nourishment for the daily recruit of the body; the digestive organs: and one for propagating the species; the organs of generation.

In taking this general survey of what would appear, *a priori*, to be necessary for adapting an animal to the situations of humanity, we observe, with great satisfaction, that man is in fact made of such systems, and for such purposes. He has them all, and he has nothing more, except the organs of respiration. Breathing we cannot account for *a priori*, we only know that it is in fact essential to life. Notwithstanding this, when we see all the other parts of the body, and their functions, so well accounted for, and so wisely adapted to their several purposes, we cannot doubt that respiration is so likewise. We find, in fact, that the blood in its circulation becomes altered in its properties, and that these are renewed by the absorption of the oxygenous or pure part of the atmosphere in the lungs; we find also, that this function is the means of supporting the temperature of the animal.

The use and necessity of all the different systems in a man's body is not more apparent than the wisdom and contrivance which has been exerted in putting them all into the most compact and convenient form, and in disposing them so, that they shall mutually receive and give helps to one another, and that all, or many of the parts, shall not only answer their principal end or purpose, but operate successfully and usefully in many secondary ways.

If we understand and consider the whole animal machine in this light, and compare it with any machine, in which human art has done its utmost, suppose the best constructed ship that ever was built, we shall be convinced, beyond the possibility of doubt, that there is intelligence and power far surpassing what humanity can boast of.

In making such a comparison, there is a peculiarity and superiority in the natural machine, which cannot escape observation. It is this; in machines of human contrivance or art there is no internal power, no principle in the machine itself, by which it can alter or accommodate itself to any injury, which it may suffer, or make up any injury which is reparable. But in the natural machine, the animal body, this is most wonderfully provided for by internal powers in the machine itself, many of which are not more certain or obvious in their effects, than they are above all human comprehension as to the manner and means of their operation. Thus, a wound heals up of itself; a broken bone is made firm again by callus; a dead part is separated and thrown off; noxious juices are driven out by some of the emunctories; a redundancy is removed by some spontaneous bleeding; a bleeding naturally stops of itself; and a great loss of blood, from any cause, is in some measure compensated by a contracting power in the vascular system, which accommodates the capacity of the vessels to the quantity contained. The stomach gives information when the supplies have been expended, represents with great exactness the quantity and quality of what is wanted in the present state of the machine, and in proportion as she meets with neglect, rises in her demand, urges her petition in a louder voice, and with more forcible arguments. For its protection, an animal body resists heat and cold in a very wonderful manner, and preserves an equal temperature in a burning and in a freezing atmosphere.

There is a farther excellence or superiority in the natural machine, if possible, still more astonishing, more beyond all human comprehension, than what we have been speaking of. Besides those internal powers of self-preservation in each individual, when two of them co-operate, or act in concert, they are endued with powers of making other animals or machines like themselves, which again are possessed of the same

powers of producing others, and so of multiplying the species without end. These are powers which mock all human invention or imitation, they are characteristics of the Divine Architect.

As the body is a compound of solids and fluids, anatomy is divided into,

1. The anatomy of the solids, and

2. The anatomy of the fluids.

The solids of the human body consist of,

1. Bones, which give support to the other parts of the body;

2. Cartilages, or gristles, which are much softer than the bones, and also flexible and elastic;

3. Ligaments, which are more flexible still, and connect the ends of the bones to each other;

4. Membranes, or planes of minutely interwoven and condensed cellular substance;

5. Cellular substance, which is formed of fibres and plates of animal matter more loosely connected, and which forms the general uniting medium of all the structures of the body;

6. Fat, or adipous substance, an animal oil contained in the cells of the cellular membrane;

7. Muscles, which are bundles of fibres, endued with a power of contraction; in popular language they form the flesh of an animal;

8. Tendons, hard inelastic cords, which connect the muscles or moving powers to the bones or instruments of motion.

9. Viscera, which are various parts, adapted for different purposes in the animal economy, and contained in the cavities of the body, as the head, chest, abdomen, and pelvis;

10. Glands, organs which secrete or separate various fluids from the blood;

11. Vessels, which are membranous canals, dividing into branches, and transmitting blood and other fluids;

12. Cerebral substance, or that which composes the brain and spinal marrow, which is a peculiar soft kind of animal matter;

13. Nerves, which are bundles of white fibrous cords, connected by one end to the brain, or spinal marrow, and thence expanded over every part of the body, in order to receive impressions from external objects, or to convey the commands of the will, and thereby produce muscular motion.

The fluids of the human body are,

1. Blood, which circulates through the vessels, and nourishes the whole fabric;

2. Perspirable matter, excreted by the vessels of the skin;

3. Sebaceous matter, by the glands of the skin;

4. Urine, by the kidneys;

5. Ceruminous matter, secreted by the glands of the external ear;

6. Tears, by the lachrymal glands;

7. Saliva, by the salivary glands;

8. Mucus, by glands in various parts of the body, and by various membranes.

9. Serous fluid, by membranes lining circumscribed cavities;

10. Pancreatic juice, by the pancreas;

11. Bile, by the liver;

12. Gastric juice, by the stomach;

13. Oil, by the vessels of the adipose membrane;

14. Synovia, by the internal surfaces of the joints, for the purpose of lubricating them;

15. Seminal fluid, by the testes;

16. Milk, by the mammary glands.

The account of these animal fluids will be found chiefly under the article PHYSIOLOGY.

The anatomical description of the body is technically arranged under the following heads:

1. Osteology, or the description of the structure, shape, and uses of the bones.

2. Syndesmology, or a description of the connection of bones by ligaments, and of the structure of the joints.

3. Myology, or doctrine of the moving powers or muscles.

4. Angeiology, or description of the vessels engaged in nourishing the body, in absorption, and in the removal of superfluous parts.

5. Adenology, or account of the glands in which various liquors are separated or prepared from the blood.

6. Splanchnology, or a description of the different bowels which serve various and dissimilar purposes in the animal economy.

7. Neurology, under which title the brain, the nerves, and the organs of sense must be comprehended.

The functions carried on in animals, in the explanation of which physiology consists, and for the detailed account of which we refer the reader to the article PHYSIOLOGY, may be thus arranged.

1. Digestion, or the conversion of extraneous matter into a substance fit for the nourishment of their own bodies.

2. Absorption, by which the nutritive fluid is taken up and conveyed into the vascular system, and by which the old parts of our body are removed.

3. Respiration, or the exposure of the nutritive fluid to the action of the atmosphere.

4. Circulation, or the distribution of the converted matter to every part of the animal, for its repair and augmentation. The process is named circulation, from the mode in which it is carried on in the generality of animals.

5. Secretion, or the separation, and deposition of the particles composing the structure of animals and vegetables, as well as the formation of various substances which they produce from the circulating fluids.

6. Irritability, or the principle by which living fibres contract, by means of which absorption and circulation are carried on, and which is more strikingly manifested by the occasional exertions of the muscular powers.

7. Sensation, by which animals become conscious of their own existence, and of that of external bodies.

8. Generation, by which new beings, similar to the parents, are formed and produced.

PARTICULAR ANATOMICAL DESCRIPTION OF THE HUMAN BODY.

After a cursory notice of the cellular substance, which forms the grand uniting medium of the various structures in the body, and of membranes, which are formed of that substance, we shall proceed to describe the other parts, chiefly according to the technical arrangement above mentioned.

Cellular substance, or cellular membrane, tela cellulosa or mucosa of Latin writers, is the medium which connects and supports all the various parts and structures of the body. Any person may gain a general notion of this substance, by observing it in joints of veal, where it is always inflated by the butchers. It consists of an assemblage of fibres and laminæ of animal matter, connected to each other so as to form innumerable cells or small cavities, from which its name of *cellular* is derived. It pervades every part of the animal structure. By joining together the minute fibrils of muscle, tendon, or nerve, it forms obvious and visible fibres; it collects these fibres into large fasciculi; and by joining such fasciculi or bundles to each other, constitutes an entire muscle, tendon, or nerve. It joins together the individual muscles, and is collected in their intervals. It surrounds each vessel and nerve in the body; often connecting these parts together by a firm kind of capsule, and in a looser form joining them to the neighbouring muscles, &c. When condensed into a firm and compact structure, it constitutes the various membranes of the body, which, by long maceration in water, may be resolved into a loose cellular texture. Its general condensation on the surface of the body constitutes the cutis, or true skin, which is, in fact, a membrane. In the bones it forms the basis or ground-work of their fabric, a receptacle, in the interstices of which the earth of bone is deposited. As cellular substance is entirely soluble in boiling water, it is ascribed by chemists to that peculiar modification of animal matter termed *gelatine*. In consequence of its solution by the united agencies of heat and moisture, the muscular fibres separate from each other, and form the other structures of the body. This effect is seen in meat which is subjected to long boiling or stewing for the table, or indeed in a joint which is merely overboiled.

Its watery solution assumes, when cold, the appearance of jelly; and, after a particular mode of preparation, constitutes glue.

The interstices of the cellular substance are lubricated and moistened by a serous or watery fluid, poured out by the exhalant arteries, and again taken in by the lymphatics. It thus acquires a pliancy and softness, which adapt it particularly to serve as a connecting medium for parts, which have motion on each other. The importance of this property will be best understood by observing the effects of its loss. Inflammation or abscess often causes an induration or consolidation of the cellular texture, by which the integuments are fixed to the muscles, the muscles are firmly united to each other, and to the surrounding parts, and the motions of the whole are considerably impaired.

From the universal extent of this cellular texture, two conclusions may be drawn; 1st, it forms the basis of the whole animal fabric, in such a way, that if we conceive every part removed but this, the form of the whole would still be expressed in cellular substance; 2ndly, it forms a connection and passage between all parts of the body, however remote in situation, or dissimilar in structure. For the cells of this substance every where communicate; as we may collect from facts of the most common and familiar occurrence. In emphysema, where air escapes from the lung wounded by a broken rib, into the cellular

substance, it spreads rapidly from the chest into the most remote parts of the body; and has even been known to gain admission into the eye-ball. A similar diffusion of this fluid may be effected by artificial inflation, which is commonly practised by butchers on the carcases of calves. In anasarca, or preternatural accumulation of fluid in the cellular substance, the most depending parts are the most loaded; and punctures in these drain the water off from the whole body.

Adipous substance, or fat.—The cells of the cellular substance, in many parts of the body, are destined for the reception of a fluid, termed fat. This is of an unctuous nature, inflammable, lighter than water, usually inodorous, and, generally speaking, similar to the vegetable oils. It is white in young animals, and becomes yellower as they advance in age: this difference may be seen in the carcases of a calf and cow. It is always more or less fluid in the living subject; in carnivorous animals, and in man, it retains much of its oily appearance after death; but in herbivorous animals it constantly assumes a concrete form. Dr. Hunter called those parts of the cellular substance, which contain fat, *adipous cellular substance;* and distinguished the other by the epithet *reticular*.

As the fat is deposited in cells, it assumes in general a kind of granular form. It varies considerably in consistence. That of the orbit is the softest in the body, and forms a well-known epicurean *bonne bouche*, in a boiled calf's head. The fat about the kidneys becomes particularly hard after death, and is called suet. The globules or portions of this are very large, and it contains on the whole less cellular substance than any fat in the body. There is generally a layer of fat under the skin; whence a membrana adiposa has been sometimes enumerated as one of the common integuments of the body.

Some parts of the body never contain fat, even in subjects who have the greatest accumulation of this fluid. This is the case with the scrotum, the integuments of the penis, and the eyelids: it is obvious that the functions of these parts would be completely destroyed, if they were subject to the enormous accumulations of fat, which occur in other parts of the body. Several of the viscera also never contain any fat, probably for the same reason; this is the case with the brain and lungs.

The quantity of fat varies according to the age, the state of health, and the peculiar habit or disposition of the individual. It is not found in the early periods of fœtal existence; and cannot be distinguished with any certainty sooner than the fifth month after conception.

In the fœtus, and for some time after birth, the fat is confined to the surface of the body, and is only found in a stratum under the skin. It begins, however, gradually to be deposited in the intervals of the muscles, and on the surface of some viscera. In old subjects, however thin they may seem on an external view, there is always much fat, penetrating even the substance of the muscles: the bones are greasy throughout; the heart is more or less loaded, as are also the parts in the abdomen.

There is a considerable difference in the quantity of fat in different individuals; and in some there is a propensity or disposition to its accumulation; a sedentary life, copious food, and tranquil state of the mind, are particularly favourable to the increase of fat, which sometimes proceeds to such a pitch, from the continuance of these causes, that it must be considered as a disease, and is attended with the greatest inconvenience to the individual. General diseases of the frame are commonly attended with an absorption of the fat from the cellular substance: acute disorders cause a very rapid emaciation. In no case is the adipous substance more completely removed from the whole body than in anasarca, where its place is supplied by a serous fluid.

The uses of the fat seem to be, in part, common to it with the cellular substance: it connects contiguous parts, and at the same time prevents their coalition. It admits of their moving on each other with freedom and facility. Its deposition under the integuments gives a roundness and convexity to the surface, on which the beauty of the human form principally depends. Indeed, its accumulation in particular situations immediately influences the outline of the part; as in the orbit, the cheek, and the buttocks. The effects of its loss is most disagreeably manifested in the lank cheek and hollow eye of an emaciated patient.

It has been supposed that the fat absorbed under certain circumstances is applied to the nutrition of the body; as in hybernating animals.

Membranes.—In the foregoing observations on cellular substance, we have stated that membranes are formed by a condensation of that substance. They consist of

thin sheets of compacted and close cellular texture. This is proved by long maceration in water. The fluid gradually penetrates the interstices, and resolves the membrane into a loose and floculent substance. They are found in every variety of density and softness.

A grand use of membranes is to line what anatomists call the *circumscribed cavities* of the body. These are hollow spaces, containing the different viscera, and in every instance completely and accurately filled by such viscera; so that the term cavity, when used by anatomists, does not, as in common language, denote a void or empty space.

Membranes have a smooth internal polished surface, turned towards the contained viscera. This is constantly moistened by a lubricating fluid exhaled by the minute arteries of the part, and bestows on the surface of the membrane the greatest softness and smoothness. Hence the motions of the viscera are performed with perfect facility, and they are prevented from adhering to each other, or to the sides of the containing cavity. The extent of such cavities is bounded and defined by the lining membranes, and hence arises the epithet *circumscribed.* To increase the facility of motion, the surface of the contained viscera is covered by productions of the same membrane, and always therefore possesses the same smoothness and polish with the sides of the cavity. In the carcase of an animal just slaughtered, the lubricating secretion flies off in the form of a fine vapour, when the cavity of the belly or chest is laid open. It is nothing more than an increase of this natural secretion, combined perhaps with a deficient absorption, that gives rise to dropsies of the different cavities.

The opposite or external surface of the membrane is rough and cellular; and adheres to the various parts, which form the sides of the cavity.

Another use of membranes is to form blood-vessels, or tubes, for conveying the nutritious fluid to all parts of the body. The bore or hollow of the tube is perfectly smooth and polished, so that the blood experiences no obstruction in its course; and the external surface is rough, to connect it with the surrounding parts. In a similar manner are formed the stomach and intestines, which receive the food; the urinary bladder, which holds the urine, &c.

It must be obvious, that for all the purposes which we have enumerated, whether for lining circumscribed cavities, for conveying the blood, for receiving the food, or holding any other liquors, it is essentially necessary that membranes should be impermeable to fluids in the living state.

OSTEOLOGY.

The bones are the most solid parts of the body. They are composed of a vascular substance, not differing materially in structure from that of the rest of the body, except that there is deposited in its interstices an earthy matter, which gives to the whole mass rigidity, strength, and a permanent figure. The nutrient vessels of arteries, membranes, and ligaments, occasionally deposit lime, and cause the ossification of those parts.

The account of the original formation of the bones in the fœtus, is technically termed *osteogeny.* The parts of the young fœtus, which are afterwards to become bones, are at first cartilaginous; and their substance is rendered white and firm in proportion to the quantity of lime deposited in it. The quantity at the time of birth is only sufficient to give firmness to the whole mass, not to prevent its flexibility.

The extremities of all the long bones consist of large portions of cartilage, and these, by degrees become bony. The formation of bone begins in the centre of the cartilage, and gradually extends from thence to the remote parts, so that the separate piece of bone, formed at the extremity, remains till near the time of puberty, conjoined to the body of the bone by a crust of cartilage. In this state it is technically termed an *epiphysis.* The body, or middle part of the bone, is called the *diaphysis.* The projecting parts, or processes of bones, are also in many instances originally *epiphyses.* The time by which these epiphyses are consolidated by a bony union with the diaphysis, varies in different bones, but it is not prolonged in any much beyond the age of puberty.

We perceive an evident advantage in the bones of the fœtus being formed as they are. Their flexibility admits of the form of the limbs becoming adapted to the varying figure of the pelvis, through which they must pass; and their elasticity, which is powerful, restores them afterwards to their natural shape.

The animal substance contained in bones is demonstrated by immersion in weak acids, which dissolve the earth, and leave a kind of cartilage similar to that in which the bone was originally formed. Long boiling in a close vessel removes the gelatinous sub-

stance, which is dissolved in the water. The earth of bones is demonstrated by calcination, which drives off the animal matter, and leaves the earth alone behind. This earth consists chiefly of phosphate of lime; but there is also a small proportion of carbonate of lime. In young subjects the animal substance predominates; and the bone appears redder, in consequence of the arteries being larger and more numerous. The bones of old persons contain more earth, and are consequently whiter and less vascular.

Some recent experiments have shewn the quantity of jelly contained in bones to be much larger than was supposed, and as it forms a very good soup when dissolved in water, the circumstance is of considerable importance, as furnishing an article capable of supplying much wholesome nutriment. The quantity of soup furnished from a given bulk of bruised or pounded bones, boiled in a vessel with a closed lid, considerably exceeds that which can be extracted from the same quantity of meat. Of course the articular heads of bones, and the reticular texture, in general furnish the greatest quantity.

It has been generally taught, that bones are composed of fibres and laminæ: the fact is that they consist of a reticulated texture, very similar to cellular substance in other parts of the body.

According to the obvious differences in their forms, bones are divided into the long and flat.

Two kinds of structure may be observed in all bones: in the one, the bony substance is condensed, and leaves no interstices; in the other, there is a mere net-work of bony fibres and plates, leaving numerous intervals. The latter is termed the cancellous substance of bones.

The cylinder of a long bone is composed entirely of the firmer substance, and in its centre is hollowed out to contain the marrow. In those extremities of the bones, which form the joints, which are greatly expanded, in order to increase the extent of surface, there is a thin layer of the compact substance, but all the interior is cancellous. In broad or flat bones, the firmer substance is formed into two plates or tables, and the interval between these is occupied by cancelli.

Many advantages arise from this arrangement of the earth of bones. The long bones are made slender in the middle, to allow of the convenient collocation of the large muscles around them; they become expanded at their extremities, to afford an extent of surface for the formation of joints, and the support of the weight of the body. A cavity is left in the middle; for if all the earthy matter had been compacted into the smallest possible space, the bones would have been such slender stems, as to be very unsuitable to their offices; and if they had been of their present dimensions, and solid throughout, they would have been unnecessarily strong and weighty.

The phenomena, which result from feeding an animal with madder, sufficiently demonstrate the existence of blood-vessels and absorbents in the bones. There is a strong attraction between the earth of bone and the colouring matter; by means of which they unite and form a beautiful red substance. The whole of the bones of an animal assume this colour soon after an animal has been taking the madder. If it be left off, the bones in a short time resume their natural white appearance, from the absorption of the red colouring substance. The short time in which growing bones become thoroughly died, and in which again the preternatural tint is lost, prove that even in these, the hardest parts of our frames, there is a process of removal of old parts, and deposition of new ones constantly going on.

That bones possess nerves, as well as arteries, veins, and absorbents, cannot be doubted. Although in the natural state they seem to be insensible, they become extremely painful when diseased; and again, a fungus which is sensible sometimes grows out of a bone, though it may have no connexion whatever with the surrounding soft parts; of course it must have derived its nerves, by means of which it possesses sensation, from the bone out of which it arose.

Bones are covered by a strong and firm membrane, termed *periosteum*, on which the vessels are first distributed; from this they descend into the substance of the bone. The vessels enter through holes, which are evident on the surface, and which are larger and more numerous in the extremities of the long bones than in the middle.

OF THE MARROW.

This is of an oily nature. It hardens, when cold, in herbaceous animals; but it remains fluid in those which are carnivorous. It has a reddish and bloody appearance in young animals; but this soon goes off. It is contained in fine membranous cells, which do not communicate with each

other. The marrow occupies the tube left in the middle of the long bones, and also fills the cancelli of their extremities.

The cellular substance, which contains the marrow, being condensed upon the inside of the walls of the bone, and adhering to them, has been termed the *periosteum internum*.

We observe in the principal bones arteries, much larger than those which nourish the bone, penetrating these bodies obliquely, and spreading their branches upon the medullary cells.

Various unsatisfactory opinions have been proposed concerning the use of the marrow. The utility of the bones being formed as they are, small and tubular in the middle, expanded and spongy at their extremities, has been already explained. If then spaces are necessarily left in their interior parts, those spaces must be filled with something; for they cannot be left void, or the immense pressure of the atmosphere would crush their sides, and destroy the vacuum. There is no matter in the animal body more suitable to fill their spaces than the marrow; and it is to be regarded as a part of the adipous system of the animal.

From the circumstances which have been detailed in the foregoing account, *viz.* the great and general vascularity of bones; the quantity of soft substance existing in every part of them; their growth and mutation of form in disease, &c. it is natural to conclude, that there exist in the composition of every bony fibre, arteries for its formation, absorbents for its removal, cellular substance for the connexion of its parts, and nerves to give animation to the whole. In this view of the subject, we see no essential difference of structure between bones and other parts of the body; nor do we expect any essential difference in the functions of their nutrient and other vessels. We naturally conclude that bony fibres are formed and repaired, and that they undergo mutation and removal in the same manner, and from the same causes that soft parts do.

CARTILAGE

is a semipellucid substance, of a milk-white or pearly colour, entering into the composition of several parts of the body. It holds a middle rank, in point of firmness, between bones or hard parts, and the softer constituents of the human frame. It appears, on a superficial examination, to be homogeneous in its texture; for, when cut, the surface is uniform, and contains no visible cells, cavities, nor pores; but resembles the section of a piece of glue. It possesses a very high degree of elasticity; which property distinguishes it from all other parts of the body. Hence it enters into the composition of parts, whose functions require the combination of firmness with pliancy and flexibility: the preservation of a certain external form, with the power of yielding to external force or pressure.

Cartilages are covered by a membrane, resembling, in texture and appearance, as well as in its office, the periosteum of bones: this is termed the perichondrium. They receive arteries and veins from this membrane: these vessels, however, have never been demonstrated in the cartilaginous crusts of articular surfaces. Absorbent vessels cannot be actually shewn, but their existence is abundantly proved by many phenomena. The conversion of cartilage into bone is alone sufficient for this purpose. The cartilaginous substance is gradually removed, as the formation of the bone advances. In affections of the joints, their cartilaginous coverings are often both entirely destroyed, or partially removed; which appearances can only be ascribed to the action of absorbent vessels.

It does not seem to possess nerves, as it is entirely destitute of sensibility.

The thinner cartilages of the body are resolved by maceration into a kind of fibrous substance: *e. g.* those of the organs of sense. Those of the ribs are found by long maceration to consist of concentric oval laminæ. In some there are tendinous fibres intermixed; as in those of the vertebræ.

Anatomists divide cartilages into two kinds: the temporary and the permanent. The former are confined to the earlier stages of existence; the latter commonly retain their cartilaginous structure throughout every period of life.

The temporary cartilages are those in which the bones of the body are formed. They are hence called by the Latin writers *ossescentes*. All the bones of the body, except the teeth, are formed in a nidus of cartilage. The form of the bone, with its various processes, is accurately represented in these cartilaginous primordia; and it is the substance alone which changes.

The permanent cartilages are of various kinds. We find them composing the external ear, external aperture of the nostrils, and eye-lids. The larynx is entirely composed of this substance; and the trachea, with its branches, is furnished with cartila-

ginous hoops, by which these tubes are kept permanently open, for the ready passage of air to and from the lungs.

The bodies of the vertebræ are joined by large masses of a peculiar substance, partaking of the properties and appearance of cartilage and ligament; which allow of the motions of these parts on each other, without weakening the support that is afforded to the upper parts of the body in general, and to the head in particular, by the vertebral column. These cartilages impart a great elasticity to the spine; by which the effects of concussion from jumping, from falls, &c. are weakened, and destroyed, before they can be propagated to the head. When the body has been long in an erect position, the compression of these cartilages, by the superior parts, diminishes the height of the person. They recover their former length, when freed from this pressure: hence a person is taller when he rises in the morning, than after sustaining the fatigues of the day, and the difference has sometimes amounted to an inch.

Cartilages are sometimes interposed between the articular surfaces of bones; where they fill up irregularities, that might otherwise impede the motions of the part; and increase the security of the joint, by adapting the articular surfaces to each other.

The articular surfaces of bones are, in every instance, covered by a thin crust of cartilage, having its surface most exquisitely polished, by which all friction in the motions of the joint is avoided, and the ends of the bones glide over each other with the most perfect facility.

Nomenclature of bones.—The processes or apophyses of bones bear different names according to their figures. Hence we find them described under the terms of head (roundish ball); condyle (a flattened head); neck; tuberosity; spine; &c. others have particular names from supposed resemblances.

The cavities or depressions of bones are called cotyloid, when deep; glenoid, when shallow. Again, we have pits, furrows, notches; sinuosities, fossæ, sinuses, foramina, and canals.

Connection of bones.—Anatomists have divided these into three classes; Symphysis, Synarthrosis, and Diarthrosis.

The term symphysis merely denotes the union of the conjoined bones, without any reference to peculiar form or motion; hence it is divided, according to the means by which it is effected, into

1. Synchondrosis, where cartilage is the connecting medium: this is exemplified in the junction of the ribs and sternum; of the bodies of the vertebræ; and of the ossa pubis:

2. Synneurosis or syndesmosis; where ligaments are the connecting bodies, as in all the moveable articulations:

3. Syssarcosis; where muscles are stretched from one bone to another.

The synarthrosis, or immoveable conjunction of bones, consists of,

1. Suture; where the bones are mutually indented, as if sewn together:

2. Harmonia; where the conjunction is effected by plane surfaces.

3. Gomphosis; where one bone is fixed in another, as a nail is in a board. The teeth afford the only specimen.

Diarthrosis, or moveable conjunction of bones. The conjoined parts of the bones are covered with a smooth cartilage, and connected by one or more ligaments. It has three subdivisions; *viz.*

1. Enarthrosis, or ball and socket; where a round head of one bone is received into a cavity of another, and consequently is capable of motion in all directions;

2. Arthrodia; where the cavity is more superficial, and much motion not allowed;

3. Ginglymus; where the motions are restricted to two directions, as in the hinge of a door.

The skeleton consists of an assemblage of all the bones in the body, excepting the os hyoides. It is said to be a natural skeleton, when the bones are connected by means of their own ligaments or cartilages; an artificial one, when wire or other extraneous substances are employed.

It is divided into the head, trunk, and extremities.

The head consists of the cranium and the face. The former of these parts consists of 1 or 2 ossa frontis; 2 ossa parietalia; 1 os sphenobasilare; 2 ossa temporum; 2 mallei; 2 incudes; 2 stapedes; and 1 os æthmoideum; on the whole, of 13 or 14 bones.

The face has 2 ossa maxillaria superiora; 2 ossa palati; 2 ossa malæ; 2 ossa nasi; 2 ossa lacrymalia; 2 ossa turbinata inferiora; 1 os vomer; 1 maxilla inferior; 32 teeth; on the whole, 46 bones.

The tongue has 5 ossa lingualia.

The bones of the head are therefore 59 or 60; with the lingual bones 64 or 65.

In the neck there are 7 cervical vertebræ; in the chest 12 dorsal vertebræ, 24 ribs;

2 or 3 bones of the sternum: in the loins 5 lumbar vertebræ; in the pelvis 1 sacrum, 4 ossa coccygis, 2 ossa innominata.

Therefore the whole trunk has 57 or 58 bones.

The shoulders have 2 clavicles and 2 scapulæ; the arms 2 humeri; the fore-arms 2 ulnæ and 2 radii; the wrists 2 ossa navicularia; 2 ossa lunata; 2 ossa cuneiformia; 2 ossa orbicularia; 2 ossa trapezia; 2 ossa trapezioidea; 2 ossa capitata; 2 ossa unciformia: the metacarpi 10 metacarpal bones: the fingers 10 posterior phalanges; 8 middle phalanges, 10 anterior phalanges, and 8 sesamoid bones.

The bones of the upper extremities are in the whole 72.

The thighs have 2 femora: the legs 2 tibiæ, 2 patellæ, and 2 fibulæ: the tarsi 2 astragali, 2 ossa calcis, 2 ossa navicularia, 6 cuneiform bones, 2 ossa cuboidea: the metatarsi 10 metatarsal bones: the toes 10 posterior phalanges, 8 middle phalanges, 10 anterior phalanges, and 6 sesamoid bones.

The bones of the lower extremities are 66.

The whole skeleton contains 259 or 261 bones.

Of the bones just enumerated, the os frontis, spheno-occipitale, ethmoideum, vomer, inferior maxilla, the vertebræ, sacrum, and os coccygis, the bones of the sternum, and the os linguale medium, are single bones; and being placed in the middle of the body, are consequently symmetrical. Of all the other bones, there is a pair consisting of a bone for the right, and another for the left side.

The structure of the whole skeleton is therefore symmetrical; since an imaginary perpendicular line drawn through the whole would divide even the single bones into a right and a left half exactly resembling each other. This observation must however be taken with some allowance; since the corresponding bones of one side are not always perfectly similar to those of the opposite; nor do the two halves of the single bones always exactly agree in form, &c.

The entire natural skeleton of a man of middle stature, in a dried state, weighs from 150 to 200 ounces; that of a woman from 100 to 160 ounces.

Bones of the head.—The cranium is the oval bony cavity containing the brain; the face is placed at the anterior and lower part of this cavity, and holds some of the organs of sense, and the instruments of mastication.

The bones of the head are joined by sutures, a mode of union nearly peculiar to themselves; hence, when all the soft parts are destroyed by maceration, they still remain most firmly connected to each other, excepting the front teeth and the lower jaw. The sutures are formed by numerous sharp and ramified processes of the opposed edges of the different bones, shooting into corresponding vacuities of each other. In some instances, however, the bones seem to be joined by the opposition of plane surfaces, and here the union appears externally like a mere line, instead of the irregular zigzag course, which it takes in the former case. The last mentioned junction is called harmonia.

In the fœtal state, the bones of the cranium do not touch each other, but are separated by considerable intervals of membrane, and have thin extenuated margins, which allow them to ride over each other when subjected to pressure. The larger and more conspicuous of these intervals are called fontanelles, and allow of the pulsation of the brain being felt in a young subject. The importance of this structure, in allowing the head to accommodate itself to the varying figure of the parts, through which it passes in the act of parturition, and to sustain the violent pressure, which it experiences in the same act, is sufficiently obvious. In the progress of ossification the edges of the bones meet each other, and become united by the sutures. The use of these in the adult cranium, cannot be satisfactorily asssigned; nor do we see any difference that would arise, if the head had been composed of one piece only, without any suture. In old persons the sutures often become more or less generally obliterated.

The individual bones are very firmly connected by this mode of union. The edges of the different bones overlap each other at different parts, so that they are mechanically locked together, and cannot be driven in by any force *ab externo.*

The bones of the cranium are composed of two plates of compact bony substance, called the external, and internal or vitreous tables; and an intervening more or less obvious reticular texture termed diploe. The proportion of these constituent parts varies very considerably; the diploe is in no case of a very loose or open texture. The thickness of individual skulls is subject to great variety; and there is much difference in the various parts of the same skull. For the internal surface is every where exactly

moulded to the form of its contents, instead of influencing them, as we might have expected *a priori*. Hence the convolutions of the brain, the vessels, which ramify on its surface, &c., all leave prints on the inner table. The ordinary thickness varies from about the fifth of an inch to almost a mere line.

The common number of the bones of the cranium is, as we have already stated, 7; but this is often increased by small portions formed between the others, and surrounded by distinct sutures. These are called ossa triquetra, or wormiana.

The form of the cranium is elliptical, and pretty regularly so, particularly on the front, upper and back part, and sides. The smaller circle of the ellipse is in front, and the larger behind. It is tolerably smooth externally, except its basis, and it is almost entire or unperforated, except at the same part. In this situation, however, it possesses numerous holes, or as they are technically named, foramina, which transmit blood-vessels to the brain, and the nine pairs of nerves, which arise from that organ.

The upper and lateral parts of the cranium constitute a bony vault or arch, for protecting the brain; this part is distinguished by the name of the skull cap.

Individual bones of the head.—The os frontis forms the upper and anterior part of the skull; the eyebrow, and the roof of the orbit.

The ossa parietalia are called also ossa bregmatis, since the fontanelles or bregmata are formed between their edges. They compose the whole upper and most of the lateral parts of the skull; and possess an irregularly quadrangular figure.

The ossa temporum compose the lower part of the sides, and the middle of the basis of the cranium. They are divided into a squamous portion, a mamillary, and a petrous portion. The former of these has a process contributing to the zygoma, or bony arch, at the side of the cranium, under which the temporal muscle passes. The second is also remarkable, by forming a large nipple-like protuberance towards the basis cranii. The third, which projects into the cavity of the skull, contains the organ of hearing.

The os spheno-occipitale has generally been described as two bones. The occipital portion forms the posterior portion of the basis cranii, and a part also of the back of the bony case.

The sphenoid portion is situated in the middle of the base of the skull, and extends across it from one temple to another. It is extremely irregular in its figure, and divided into a body placed in the middle, two alæ on the sides, and two pterygoid processes projecting downwards.

The os ethmoides occupies the middle of the forepart of the basis cranii. It lies in the interval between the two orbits, and contributes to the cavity of the nose. It consists of an irregular assemblage of bony cells, and processes of a very thin and delicate formation. It has a cribriform or horizontal plate towards the brain; a nasal or perpendicular plate; 2 turbinated bones; cells; and two orbital plates.

The sutures joining these are the coronal, between the os frontis and the two ossa parietalia; the sagittal, between the two ossa parietalia; the lambdoidal, joining the ossa parietalia to the os occipitis; the squamous, between the temporal and parietal bones.

The foramina occurring in the cranium, for the transmission of nerves are; 1, those of the cribriform plate of the ethmoid bone: 2, f. optica: 3, f. lacera orbitalia: 4, f. rotunda: 5, f. ovalia: 6, meatus auditorii interni: 7, f. lacera in basi cranii: 8, f. condyloidea anteriora: 9, foramen magnum.

Those which transmit blood vessels are; 1, canales carotici: 2, f. spinosa: 3, f. lacera in basi cranii: 4, f. magnum.

Bones of the face.—The ossa nasi constitute the arch of the nose. The ossa lacymalia or unguis are placed at the forepart of the inner edge of the orbits, and contain an excavation which holds the lacrymal bag.

The ossa malarum form the prominences of the cheeks.

The ossa maxillaria superiora form the largest portion of the upper jaw, and most of the bony palate, or roof of the mouth; they contain also the upper teeth.

The ossa palati form the back part of the bony palate.

The ossa turbinata inferiora are situated in the cavity of the nose.

The former completes, with the nasal portion of the ethmoid, the septum that divides the two nostrils.

The maxilla inferior is articulated to the basis cranii, and holds the lower teeth.

The bones of the cranium and face compose the two orbits, or pyramidal bony cavities, holding the organs of vision; to each of these, seven bones contribute. They also form the cavity of the nose, which is very extensive, and includes portions of nearly all the bones of the face, and some of the skull. It has various cells, formed in the bones of the skull and face, opening into it,

The teeth.—These organs are composed internally of a very hard bony substance; and are covered externally by a still harder matter, called the cortex or enamel.—Each tooth has a body or crown, which is the part seen in the mouth; a neck, round which the gum adheres; and one or more fangs or roots, which are sunk in a process of the jaw, called the alveolar. These bodies are not formed in a nidus of cartilage, like bones, but on a soft vascular body, called a pulp, which may be compared to the core, on which a horn is formed. This is surrounded by a delicate membrane called the capsule of the tooth. When the teeth are being formed, these pulps and capsules with the rudiments of the teeth, are lodged in cavities hollowed out of the jaw-bone. They afterwards rise, and, piercing the gum, appear in the mouth.

Teeth differ from other bones in possessing no vessels nor nerves in their substance. As they are destined for the merely mechanical function of triturating the food, such parts would not have been suitable to this office. The pain of tooth-ach arises from a nerve, which, with a vessel, resides in a hollow, formed in the centre of the fang and body of each tooth. These parts are exposed by the decay. The teeth, in consequence of possessing no vessels, are only affected by chemical and mechanical causes. They do not repair the effects of trituration, nor of accidental injury; nor do they suffer from any of the diseases, which affect other bones.

There are two sets of teeth; the first are fewer in number, and smaller in size; as they fall out at a certain age, to make room for other larger ones, they are called deciduous or temporary. The second set lasts throughout life, and are called the adult or permanent set.

The latter consists of 32 teeth; 16 in each jaw. There are four incisores or cutting teeth in front; 2 canini or cuspidati, or dog teeth, placed one on each side of the former; 4 bicuspides behind the last; and 6 molares behind these. From the late period at which the last molaris appears, it is called the dens sapientiæ, or wise tooth.

The temporary set consists of twenty teeth; ten in each jaw. There are 4 incisores; 2 cuspidati; and 4 molares.

The permanent teeth are lodged at first in cavities of the jaw, near the roots of the temporary ones; and as these last are shed, rise up to supply their places.

The bone of the tongue is called os hyoides from its very accurate resemblance to the Greek υ. It consists of a body, two cornua, and two appendices, which are in fact so many separate bits of bone.

The bones of the trunk consist of those of the spine, thorax, and pelvis.

The spine consists of twenty-four true or moveable vertebræ; an os sacrum, and an os coccygis (which indeed is composed of four pieces): these last bones bearing considerable resemblance to the vertebræ, are called sometimes the false vertebræ.

Each vertebra has a body, which is situated anteriorly, and consists of a cylindrical piece of bone; a perforation behind this, in which the spinal morrow runs; two superior and two inferior articulating processes, by which it is joined to the bone immediately above and below it; two transverse processes, and one spinous process, which projecting behind, forms a sharp ridge, from which the name of spine has been applied to the whole column.

The vertebræ are divided into three classes, according to their situation: the seven upper ones are called cervical: of these, the first, that immediately supports the head, is called the atlas; and the second, from a remarkable bony process which it possesses, the vertebra dentata. The twelve next are called dorsal vertebræ, and are distinguished by having the ribs articulated to them. The five last are called lumbar. These all differ from each other in some circumstances. The most obvious distinction arises from the size: the upper ones are the smallest, and there is a gradual increase as we descend.

The column of the spine, when viewed altogether, is not perpendicular; it stands forwards in the neck, recedes in the upper part of the back, and projects again in the loins. Holes are left between the bones for the transmission of the nerves which arise from the spinal marrow.

The sacrum forms the back of the pelvis, and is hollowed out in front. In form it is triangular, and the base is joined to the last vertebra. It is perforated by a canal, in which the termination of the medulla spinalis is lodged. Its apex has connected to it the os coccygis.

The thorax is formed by the twelve dorsal vertebræ, the ribs, and sternum. The ribs are long, curved, flattened, and narrow bones, attached behind to the dorsal vertebræ both in their bodies and transverse processes, and joined in front to a piece of cartilage. They are twelve in number, and the seven upper ones, whose cartilages are affixed to the sides of the sternum, are called true ribs; the five lower ones, the cartilages

of which do not reach so far; are called the false ribs.

The sternum is a broad and flat bone, placed in the front of the chest. It consists of two pieces of bone, and of a cartilage called the ensiform. The clavicles are articulated towards its upper parts, and the cartilages of the ribs are joined to its sides.

The pelvis is formed by the two ossa innominata, or haunch bones, the sacrum, and os coccygis. The former are very large and flat bones, expanded into a broad surface above for the support of the abdominal viscera, and the attachment of the abdominal muscles, and furnished with large tuberosities below, for the support of the body in the sitting position. Each os innominatum is divided into the ilium, ischium, and pubes. It is firmly joined to the sacrum behind, and to the opposite bone in front by the symphisis pubis. The conjoined portions form an arch, called the arch of the pubes. The cavity of the pelvis is much larger in the female than in the male, as it holds the uterus and vagina in addition to what it contains in the male, and as the fœtus passes through it in parturition.

The bones of the upper extremity are distributed into those of the shoulder, arm, fore-arm, and hand.

The shoulder contains two; the scapula and clavicle. The former is situated at the upper and outer part of the chest, and is joined to the end of the clavicle.

The humerus is a long and nearly cylindrical bone, joined by a round head to the scapula above, and articulated with the radius and ulna below.

The fore-arm has two bones; the ulna, which is joined by a hinge or ginglymus to the humerus; and the radius, which has a cavity playing upon a rounded head of that bone. The prominent extremity of the ulna, which forms the elbow, is called the olecranon. The hand is divided into the carpus, or wrist, the metacarpus, and the fingers and thumb.

The carpus contains eight bones, disposed in two phalanges, of which the first forms, with the radius, the joint of the wrist, and the second is articulated to the metacarpus.

The bones of the first phalanx are the os naviculare, lunatum, cuneiforme, and orbiculare: those of the second, os trapezium, trapezioides, capitatum, and unciforme.

The metacarpus has five bones, and each of the fingers three; the thumb only two.

In the lower extremity we have the femur, the largest of the cylindrical bones in the body. This has a round head, contained in a socket of the os innominatum: the great trochanter forms a conspicuous process at the upper and outer part of the bone. Below it has two condyles, which form part of the knee.

The leg has two bones; the tibia and fibula. A large flat portion of the former, covered only by skin, is called the shin. The foot is composed of the tarsus, metatarsus, and toes. The tarsus has seven bones:—1. Astragalus, composing the ankle, with the lower portion of the tibia and fibula. 2. Os calcis. 3. Os naviculare. 4. Os cuboides. 5, 6, 7. Ossa cuneiformia. The metatarsal bones are five in number, and the bones of each toe are three, except the great toe, which has only two.

SYNDESMOLOGY, OR DOCTRINE OF THE JOINTS.

Construction of a joint.—The opposed surfaces of bones, which form joints, are covered by a thin crust of cartilage, most exquisitely smooth and polished. Hence they move on each other in whatever direction their structure admits, without any hindrance from friction. They are tied together by strong and unyielding cords, resembling tendons, and known by the name of ligaments. These keep the surfaces of the bones together, and restrict their motions to certain directions. In order still further to promote the facility of motion, and to obviate every possibility of friction, the cartilaginous surfaces are smeared with an unctuous fluid, called synovia, which makes them perfectly slippery. This fluid is confined to the surface of the joint by means of a thin and delicate membrane, called the capsular ligament, which envelopes the joint. It is secreted from portions of a fatty substance, called the synovial glands. The ligaments are usually situated on the outside of the capsula; but in many instances they are contained in the cavity of the joint, passing from the centre of one bone to another. These are called interarticular ligaments.

Particular joints.—Joint of the lower jaw. This is formed between the condyle of the jaw, and a hollow in the temporal bone. It contains a moveable cartilage, which renders the articulation more secure, when the jaw is brought forwards on the bone under certain circumstances.

The connection of the head to the vertebræ is effected by means of two prominences of the occiput, which are received into corresponding cavities of the atlas. By this joint the nodding motions of the head are performed. But the atlas itself turns hori-

zontally round the tooth-like process of the vertebra dentata, and as the head is closely connected to the atlas, it is carried round at the same time. Therefore the lateral or rotatory motions of the head are performed by a different joint from that which performs the nodding motions. Neither of these articulations admits of very extensive motion; but the deficiency is compensated by the mobility of the vertebræ, which enable us to carry the head freely in any direction we may wish. The head rests nearly in equilibrio on the spinal column; yet, if left to itself, it would fall forwards, as the joint is not precisely in the centre of the basis cranii. To counteract this tendency there is a ligamentous substance extended from the spinous processes of the cervical vertebræ to the occiput, and called the ligamentum nuchæ. In quadrupeds this can be best seen, as the weight of the head is there supported to a much greater disadvantage. The muscles also contribute to keep the head upright; and hence, when a man drops asleep sitting, the relaxation of the extensor muscles causes the head to nod forwards.

Joints of the spine.—The spine, or backbone, is a chain of joints of very wonderful construction. Various, difficult, and almost inconsistent offices were to be executed by the same instrument. It was to be firm, yet flexible; firm, to support the erect position of the body; flexible, to allow of the bending of the trunk in all degrees of curvature. It was further also to become a pipe or conduit for the safe conveyance of a most important part of the animal frame, the spinal marrow; a substance, not only of the first necessity to action, if not to life, but of a nature so delicate and tender, so susceptible, and so impatient of injury, as that any unusual pressure upon it, or any considerable obstruction of its course, is followed by paralysis or death. It was also to afford a fulcrum, stay, or basis for the insertion of the muscles which are spread over the trunk of the body, in which trunk there are not, as in the limbs, cylindrical bones to which they can be fastened; and likewise, which is a similar use, to furnish a support for the ends of the ribs to rest upon.

The breadth of the bases, upon which the parts severally rest, and the closeness of the junction, give to the chain its firmness and stability; the number of parts, and consequent frequency of joints, its flexibility; which flexibility, we may also observe, varies in different parts of the chain; is least in the back, where strength more than flexure is wanted; greater in the loins, which it was necessary should be more supple than the back; and greatest of all in the neck, for the free motion of the head. Then, secondly, in order to afford a passage for the descent of the medullary substance, each of these bones is bored through in the middle in such a manner, as that, when put together, the hole in one bone falls into a line and corresponds with the holes in the two bones contiguous to it; by which means the perforated pieces, when joined, form an entire, close, uninterrupted channel. But, as a settled posture is inconsistent with its use, a great difficulty still remained, which was to prevent the vertebræ from shifting upon one another, so as to break the line of the canal as often as the body moves or twists, or the joints gaping externally whenever the body is bent forwards, and the spine thereupon made to take the form of a bow. These dangers, which are mechanical, are mechanically provided against. The vertebræ, by means of their processes and projections, and of the articulations which some of these form with one another at their extremities, are so locked in and confined, as to maintain in what are called the bodies or broad surfaces of the bones the relative position nearly unaltered; and to throw the change and the pressure produced by flexion almost entirely upon the intervening cartilages, the springiness and yielding nature of whose substance admits of all the motion which is necessary to be performed upon them, without any chasm being produced by a separation of the parts. I say of all the motion which is necessary; for, although we bend our backs to every degree almost of inclination, the motion of each vertebra is very small: such is the advantage which we receive from the chain being composed of so many links. Had it been composed of three or four bones only, in bending the body the spinal marrow must have been bruised at every angle.

The substances which connect the bodies of the vertebræ to each other, called the intervertebral cartilages, are thick, firm, and elastic. They are similar in shape, and nearly so in size to the bones which they join. They are thicker before than behind, so that, when we stoop forwards, the compressible cartilage, yielding to the force, brings the surfaces of the adjoining vertebræ nearer to a state of parallelism than they were before, instead of increasing the inclination of their planes, which must have occasioned a fissure or opening between them:

and their elasticity restores the body to its former state, when the compressing force ceases.

In order still further to increase the strength of the compages, and to add a greater security against luxation, the vertebræ are articulated to each other by means of the processes before mentioned. And these processes so lock in with and overwrap one another as to secure the body of the vertebra, not only from accidentally slipping, but even from being pushed out of its place by any violence short of that which would break the bone. The roots of the spinous processes are also joined to each other by very strong and highly elastic ligamentous substances, which will tend powerfully to restore the column after it has been bent forwards.

The general result is, that not only the motions of the human body necessary for the ordinary offices of life are performed with safety, but that it is an accident hardly ever heard of, that even the gesticulations of a harlequin distort his spine.

The ribs are articulated by their posterior extremities to the bodies and to the transverse processes of the vertebræ, and the true ribs are also joined by means of their cartilages to the sternum. Two great advantages are derived from the ribs having this cartilaginous portion. The effect of blows, or of any accidental violence, is eluded by the flexibility which they thus obtain; and the elastic power of the cartilages restores the ribs to their former position, after they have been raised by the intercostal muscles in breathing.

Joints of the upper extremity.—The clavicle is articulated to the sternum at one end, and to the scapula at the other.

The shoulder is formed by a round head of the humerus, which plays in a cup of the scapula; and the ends of the bones are inclosed by a thick and strong ligamentous membrane, called the orbicular ligament. There is here, therefore, every latitude of motion allowed.

In the elbow, on the contrary, the joint is a mere hinge: lateral motion is restrained by strong ligaments placed at the sides of the joint, and the fore-arm can therefore be moved only forwards and backwards. This joint is formed between the ulna and the humerus.

The wrist is formed by the junction of the radius with the first phalanx of carpal bones. Its motion is very little more than that of a ginglymus. The rotation of the hand and wrist, or what anatomists call the pronation and supination, are performed by the radius revolving round the ulna, and carrying the hand with it. In this case the elbow joint is fixed; neither does the joint of the wrist move; but the radius moves freely round the ulna, and the hand is included in the motion. The pronation and supination of the hand are well exemplified in the use of the broad-sword, and in cudgel-playing.

The carpal and metacarpal bones are united by joints and ligaments, but have no obvious motion on each other. The phalanges of the fingers are also articulated by ginglymi.

The bones of the pelvis are inseparably connected by adhering cartilaginous surfaces and immense ligaments. Such is the strength of this union, that it will yield to no force but one that would destroy and crush the whole fabric.

Joints of the lower extremity.—In the hip, which supports the whole body, and which is the centre of motion of the whole in moving from place to place, we find an apparatus admitting of extensive motion, but at the same time most carefully guarded and strengthened. There is a very large rounded head of the thigh received into a deep cup of the os innominatum. Here it can revolve freely, and is prevented from escaping by thick and strong rising edges, that guard the brim of the cavity. From these edges there springs a very tough and stout orbicular ligament, which is firmly stretched over the head of the bone, and implanted into a contracted part called the neck. In order to provide still further for the security of so important a joint as the hip, there is a short, strong ligament arising from the head of the ball, and implanted in the bottom of the cup. This affords a very great obstacle to any force tending to displace the bone; but at the same time lies in the bottom of the cavity, so as not to interfere with any of the ordinary motions.

The knee-joint is formed by three bones: the head of the tibia, the condyles of the femur, and the patella. It is a ginglymus, and its motions are accordingly restrained by two strong lateral ligaments, and it is secured still further by two immense ligamentous ropes within the cavity of the joint, called the crucial ligaments.

The ankle is a ginglymoid joint, formed by the tibia and fibula, together with the astragalus. This joint, which is an important one, as bearing the weight of the whole

body, is strengthened at its sides by two bony processes, called the internal and external malleoli or ankles.

The bones of the tarsus, metatarsus, and toes, are articulated like those of the hand.

MYOLOGY.

Muscles consist of bundles of red fibres; but the colour is not essential, since it can be removed by repeated washings and maceration.

The threads composing a muscle are enveloped by cellular substance, which connects it to the surrounding parts. Each bundle consists of numerous fibres, so small that our instruments of research cannot arrive at the ultimate or original fibre: hence any perceivable fibre, however small, is formed by the juxta-position of numerous fibrillæ; and, as we employ magnifying instruments of greater power, a fibre, which before seemed simple, resolves itself into a congeries of still more minute threads. We pass over in silence the dreams of various investigators who have busied themselves in looking for the ultimate muscular fibre; these researches do not assist us in explaining the phenomena of muscular action. The cohesion of the constituent particles of the moving fibre is maintained by the vital power: hence a dead muscle will be torn by a weight of a few ounces, which in the living body would have supported many pounds. The muscular fibre receives a copious supply of vessels and nerves.

Tendons are formed by an assemblage of longitudinal parallel fibres. They are extremely dense and tough, of a splendid white colour, which is beautifully contrasted with the florid red of a healthy muscle. The muscular fibres terminate in these bodies, and they are connected to the bones. They possess no apparent nerves, and very few and small blood-vessels.

There is always an exact relation between the joint and the muscles that move it. Whatever motion the joint, by its mechanical construction, is capable of performing, that motion the annexed muscles by their position are capable of producing. For example, if there be, as at the knee and elbow, a hinge joint, capable of motion only in the same plane, the muscles and tendons are placed in directions parallel to the bone, so as by their construction to produce that motion and no other. If these joints were capable of a freer motion, there are no muscles to produce it. Whereas, at the shoulder and the hip, where the ball and socket joint allows by its construction a rotatory or sweeping motion, tendons are placed in such a position, and pull in such a direction, as to produce the motion of which the joint admits. In the head and hand there is a specific mechanism in the bones for rotatory motion; and there is accordingly in the oblique direction of the muscles belonging to them a specific provision for putting this mechanism of the bones into action. The oblique muscles would have been inefficient without that particular articulation, and that particular articulation would have been useless without the muscles.

As the muscles act only by contraction, it is evident that the reciprocal energetic motion of the limbs, or their motion with force in opposite directions, can only be produced by the instrumentality of opposite or antagonist muscles, of flexors and extensors answering to each other. For instance, the biceps and brachialis internus, placed in the front of the arm, by their contraction bend the elbow, and with such degree of force as the case requires, or the strength admits of. The relaxation of these muscles after the effort would merely let the fore-arm drop down: for the back stroke therefore, and that the arm may not only bend at the elbow, but also extend and straighten itself with force, other muscles, as the triceps and anconeus, placed on the hinder part of the arm, fetch back the fore-arm into a straight line with the humerus with no less force than that with which it was bent out of it. It is evident therefore that the animal functions require that particular disposition of the muscles, which we call antagonist muscles.

It often happens that the action of muscles is wanted, where their situation would be inconvenient. In which case, the body of the muscle is placed in some commodious position at a distance, and it communicates with the point of action by slender tendons. If the muscles, which move the fingers, had been placed in the palm or back of the hand, they would have swelled that part to an awkward and clumsy thickness. The beauty, the proportions of the part would have been destroyed. They are therefore disposed in the arm, and even up to the elbow, and act by long tendons strapped down at the wrist, and passing under the ligament to the fingers, and to the joints of the fingers, which they are severally to move. In the same manner the muscles which move the toes and many of the joints of the foot, are gracefully disposed in the calf of the

leg, instead of forming an unwieldy tumefaction in the foot itself.

The great mechanical variety in the figure of the muscles may be thus stated. It appears to be a fixed law, that the contraction of a muscle shall be towards its centre. Therefore the subject for mechanism on each occasion is, so to modify the figure, and adjust the position of the muscle, as to produce the motion required, agreeably with this law. This can only be done by giving to different muscles a diversity of configuration, suited to their several offices, and to their situation with respect to the work, which they have to perform. On which account we find them under a multiplicity of forms and attitudes; sometimes with double, sometimes with treble tendons, sometimes with none: sometimes one tendon to several muscles, at other times one muscle to several tendons. The shape of the organ is susceptible of an incalculable variety, whilst the original property of the muscle, the law and line of its contraction, remains the same, and is simple. Herein the muscular system may be said to bear a perfect resemblance to our works of art. An artist does not alter the native quality of his materials, or their laws of action. He takes these as he finds them. His skill and ingenuity are employed in turning them, such as they are, to his account, by giving to the parts of his machine a form and relation, in which these unalterable properties may operate to the production of the effects intended.

The muscular system would afford us numerous examples of what may be called mechanical structure: *i. e.* of such contrivances employed to attain certain objects, as a human artist would adopt on similar occasions. One of the muscles of the eye-ball presents us with a very perfect pulley; by means of which the globe of the eye is moved in a direction exactly contrary to the original application of the force. This muscle, which is called the trochlearis, arises from the very back part of the orbit; it has a long and slender tendon running through a pulley in the inner part of the front margin of the orbit, and then going back to be fixed in the hind portion of the eye-ball. Thus it draws the globe obliquely upwards and forwards, although the line of the contraction of the muscle is directly backward.

In the toes and fingers, the long tendon, which bends the first joint, passes through the short tendon, which bends the second joint.

The foot is placed at a considerable angle with the leg. It is manifest, therefore, that flexible strings, passing along the interior of the angle, if left to themselves, would, when stretched, start from it. The obvious preventive is to tie them down, and this is done in fact. Across the instep, or rather just above it, the anatomist finds a strong ligament, under which the tendons pass to the foot. The effect of the ligament, as a bandage, can be made evident to the senses; for if it be cut, the tendons start up. The simplicity, yet the clearness of this contrivance, its exact resemblance to established resources of art, place it among the most indubitable manifestations of design, with which we are acquainted.

The number of the muscles of the human body is so great, and the circumstances, which demand attention in every muscle are likewise so numerous, that a particular description of each would extend this article beyond its prescribed limits. We shall therefore merely give a catalogue of the muscles; which together with the references to the annexed plates, will give the reader a sufficiently clear notion of the subject.

Muscles of the scalp.—1. Fronto-occipitalis, or epicranius.

Muscles of the ear.—1. Attollens auriculam; 2. anterior auris; 3, 4. retrahentes auriculam; 5. major helicis; 6. minor helicis; 7. tragicus; 8. antitragicus; 9. transversus auriculæ; 10. laxator tympani major; 11. laxator tympani minor; 12. tensor tympani; 13. stapedeus.

Muscles of the eye.—1. Orbicularis palpebrarum; 2. corrugator supercilii; 3. levator palpebræ superioris; 4. attollens oculi; 5. abductor oculi; 6. depressor oculi; 7. adductor oculi, these are also called recti: *viz.* rectus superior, externus, inferior, and internus; 8. obliquus superior oculi, or trochlearis; 9. obliquus inferior oculi.

Muscles of the nose.—1. Compressor narium; 2. levator labii superioris et alæ nasi; 3. nasalis labii superioris; 4. depressor alæ nasi.

Muscles of the lips.—1. Levator labii superioris; 2. zygomaticus major; 3. zygomaticus minor; 4. levator anguli oris; 5. depressor anguli oris; 6. depressor labii inferioris; 7. buccinator; 8. orbicularis oris; 9. anomalus maxillæ superioris; 10. levator menti.

Lower jaw.—1. Biventer maxillæ or digastricus; 2. masseter; 3. temporalis; 4. pterygoideus externus; 5. pterygoideus internus.

Neck.—1. Latissimus colli, or platysma myoides; 2. sterno-cleido-mastoideus.

Tongue and thyroid cartilage.—1. Omohyoideus; 2. sternohyoideus; 3. sternothyreoideus; 4. hyothyreoideus; 5. musculus glandulæ thyreoideæ; 6. stylohyoideus; 7. styloglossus; 8. mylohyoideus; 9. geniohyoideus; 10. hyoglossus; 11. genioglossus; 12. lingualis.

Muscles of the pharynx and palate.—1. Stylopharyngeus; 2. constrictor pharyngis superior; 3. constrictor medius; 4. constrictor inferior; 5. salpingo-pharyngeus; 6. palato-pharyngeus; 7. constrictor isthmi faucium; 8. levator palati mollis; 9. circumflexus palati; 10. azygus uvulæ.

Muscles of the larynx.—1. Cricothyreoideus; 2. crico-arytenoideus posticus; 3. crico-arytenoideus lateralis; 4. arytenoideus obliquus; 5. arytenoideus transversus; 6. thyreo-arytenoideus; 7. thyreo-epiglotticus.

The whole number of muscles about the head, neck, and throat, is therefore 72.

Muscles of the abdomen.—1. Obliquus externus abdominis; 2. obliquus internus abdominis; 3. transversalis abdominis; 4. rectus abdominis; 5. pyramidalis; 6. diaphragma or septum transversum.

Muscles of the thorax.—1. Sterno costalis, or triangularis sterni; 2. serratus posticus superior; 3. serratus posticus inferior; 4, 5, 6. scalenus anterior, medius, and posterior; 7 to 18. levatores breviores costarum; 19 to 21. levatores longiores costarum; 22. intercostales externi; 23. intercostales interni; 24. quadratus lumborum.

Muscles moving the head and spine.—1. Splenius capitis; 2. splenius cervicis; 3. biventer cervicis; 4. complexus; 5. trachelomastoideus; 6. transversus cervicis; 7. cervicis descendens; 8. longissimus dorsi; 9. sacrolumbalis; 10. spinalis cervicis; 11. spinalis dorsi; 12. multifidus spinæ; 13 to 22. interspinales cervicis; 23 to 28. interspinales lumborum; 29. rectus capitis posticus major; 30. rectus capitis posticus minor; 31. obliquus capitis superior; 32. obliquus capitis inferior; 33. rectus lateralis; 34. rectus capitis anticus major; 35. rectus anticus minor; 36. longus colli; 37 to 43. intertransversi colli priores; 44 to 49. intertransversi colli posteriores; 50 to 57. intertransversi dorsi; 58 to 62. intertransversi lumborum.

Muscles of the anus and perineum.—1. transversus perinei; 2. transversus perinei alter; 3. sphincter ani; 4. levator ani; 5. musculus coccygeus; 6. curvator coccygis.

Muscles peculiar to the male organs of generation.—1. Cremaster; 2. erector penis 3. accelerator; 4. compressor prostatæ.

Muscles peculiar to the female organs of generation.—1. Erector clitoridis; 2. sphincter vaginæ; 3. depressor urethræ.

The whole number of muscles of the trunk 105.

Muscles of the upper extremity.—Shoulder. 1. Pectoralis major; 2. pectoralis minor; 3. subclavius; 4. serratus magnus; 5. trapezius; 6. latissimus dorsi; 7. rhomboideus minor; 8. rhomboideus major; 9. levator anguli scapulæ; 10. deltoides; 11. supraspinatus; 12. infraspinatus; 13. teres major; 14. teres minor; 15. subscapularis.

Arm.—1. Biceps flexor cubiti; 2. brachialis internus; 3. coracobrachialis; 4. triceps extensor cubiti; 5. anconeus.

Fore-arm.—1. Supinator radii longus; 2, 3. extensor carpi radialis longior et brevior; 4. extensor carpi ulnaris; 5. extensor communis digitorum manus; 6. extensor proprius auricularis; 7. abductor longus pollicis manus; 8. extensor major pollicis manus; 9. extensor minor pollicis; 10. indicator; 11. flexor carpi ulnaris; 12. palmaris longus; 13. flexor carpi radialis; 14. pronator radii teres; 15. flexor digitorum sublimis, or perforatus; 16. flexor profundus, or perforans; 17, to 20. musculi lumbricales; 21. flexor longus pollicis manus; 22. supinator radii brevis; 23. pronator radii quadratus.

Muscles of the hand.—1. Abductor brevis pollicis manus; 2. opponens pollicis manus; 3. flexor brevis pollicis; 4. adductor pollicis; 5. palmaris brevis; 6. abductor digiti minimi; 7. flexor proprius digiti minimi; 8. adductor ossis metacarpi digiti minimi; 9, to 11. interossei interni manus; 12, to 15. interossei externi manus.

The muscles of the upper extremity are 58.

Muscles of the thigh.—1. Tensor fasciæ latæ; 2. gluteus maximus; 3. gluteus medius; 4. gluteus minimus; 5. pyriformis; 6, 7. geminus superior and inferior; 8. obturator internus; 9. quadratus femoris; 10. biceps flexor cruris; 11. semitendinosus; 12. semimembranosus; 13. psoas minor; 14. psoas major; 15. iliacus internus; 16. sartorius; 17. gracilis; 18. rectus extensor cruris; 19. vastus externus; 20. vastus internus; 21. cruralis; 22. pectineus; 23. triceps adductor femoris; 24. obturator externus.

Muscles of the leg.—1. Gastrocnemius or gemellus; 2. soleus; 3. plantaris; 4. pop-

liteus; 5. flexor longus digitorum pedis; 6 to 9. lumbricales pedis; 10. flexor longus hallucis; 11. tibialis posticus; 12. peroneus longus; 13. peroneus brevis; 14. tibialis anticus; 15. extensor longus digitorum pedis; 16. peroneus tertius.

Muscles of the foot.—1. Extensor proprius hallucis; 2. extensor brevis digitorum pedis; 3. flexor brevis digitorum pedis; 4. abductor hallucis; 5. transversus pedis; 6. abductor digiti minimi pedis; 7. flexor brevis digiti minimi pedis; 8 to 10. interossei interni pedis; 11 to 14. interossei externi pedis.

The muscles of the lower extremity are 54; and the whole number of the body 289. But as they are the same on both sides, this must be doubled, which will give 578; an enumeration which is pretty nearly correct.

ORGANS CONCERNED IN THE REDUCTION AND ASSIMILATION OF THE FOOD.

Organs of mastication and deglutition.—The two jaws, with their teeth, and the tongue, are the principal agents in the business of mastication.

The articulation of the condyle of the lower jaw with the glenoid cavity of the temporal bone, admits of the former part being moved in various directions. Its depression and elevation cause the opening and shutting of the mouth. It can be brought forwards, and carried backwards; and admits also of being moved to one side or the other. It is by a combination of these various motions that the food is masticated, or reduced into a soft and pulpy form. The different teeth, which are placed in various parts of the cavity of the mouth, are adapted, by their form and situation, for various parts of the process of mastication. The anterior ones, which have a thin cutting edge, and in which the superior overlap the inferior, act like the blades of a pair of scissars. These cut the food into smaller morsels; and serve us also in biting off a portion from any mass of food which we may be eating. The back teeth have broad bases, furnished with obtuse prominences; and they shut perpendicularly on each other. These are therefore well adapted for the grinding and trituration of the food. As their office requires a greater muscular force, they are placed in the back of the mouth, near to the centre of motion, and where, consequently, the action of the muscles is felt with the greatest effect. The cutting teeth are placed in front, at a greater distance from the attachment of the muscles, because their office does not require so great a muscular exertion.

The tongue is of considerable utility in contributing to mastication, as it serves to move the food about in the cavity of the mouth, and to subject it again to the action of the grinding teeth, when it has escaped from between their surfaces. The muscles of this organ, which we have enumerated in the myological division of the article, give it a power of motion in every direction.

But the simple act of mastication would only reduce the food into a powder, or at all events into a dry mass, that could not be swallowed without great difficulty. To obviate this inconvenience, it is plentifully moistened with a watery fluid called saliva, and is thereby converted into a soft paste, which can be conveyed into the stomach with perfect facility. The source of this fluid is in several glandular bodies situated near the mouth, and sending excretory ducts which convey the secreted fluid into that cavity. As the jaws move, their muscles compress these glands, and squeeze the secreted fluid into the mouth. The tongue is constantly employed in bringing again under the action of the teeth those portions of the food which escape from between them; and the closure of the lips prevents it from falling out of the mouth.

The true salivary glands are three in number, on each side of the head. The largest is placed in the space left between the ear and the lower jaw-bone; and is called, from its situation, the parotid. Its duct pierces the middle of the cheek. The two others are placed under the tongue, and are called the submaxillary and sublingual. Their ducts join to open by a common orifice, at the side of the membrane called the frenum of the tongue, which ties the under surface of that organ to the inside of the lower jaw. Besides these large salivary glands, there are other small granular bodies, which pour a mucous fluid into the mouth; these are named, according to their situation, glandulæ labiales, buccales, &c.

The cavity of the mouth, in which the process of mastication goes on, is not a very extensive one. There is a small space left between the cheeks and the teeth externally; but within the teeth the tongue occupies nearly the whole room. The upper boundary is formed by the palate or roof of the mouth, and the lower by the surface of the tongue. The mouth opens behind by a tolerably free communication, into a mem

branous bag, called the pharynx. The surface of the mouth is every where covered by a soft and smooth membrane. This is of course kept constantly in a moist state, as the glands above enumerated continually pour more or less of their secretion into the cavity. The membrane of the mouth is continuous with the external surface of the body; but the skin assumes a more delicate organization, as must be apparent to every body, from the change of colour at the lips.

Bag of the pharynx.—The masticated aliment is collected on the back of the tongue, which is then carried upwards, and backwards to discharge it into the pharynx. This bag is covered by muscular fibres (forming the muscles called constrictores pharyngis) which contract, successively, in order to propel the food towards the stomach. But as there are several organs communicating with the pharynx, the food might pass in a wrong direction if the parts were not so contrived as to prevent such occurrences.

In the upper and anterior part of the pharynx, the nostrils open by two large and free apertures. Between these and the entrance from the mouth, is found a fleshy and moveable curtain, called the soft palate, or velum pendulum palati. There is a small body of a pointed figure projecting from the middle of this organ, and known by the name of the uvula. This curtain and the uvula can be easily seen in the throat of a living person. It admits of being elevated so as to shut the opening of the nostrils; and its action is exemplified in the act of vomiting: the food is forcibly thrown into the pharynx, and would pass mostly into the nose, were it not prevented by the soft palate. From the uvula the membrane is continued on either side, in an arched form, towards the root of the tongue, and it contains a glandular body called the tonsil, which secretes a mucous fluid to lubricate the parts, and facilitate the passage of the aliment. The larynx opens into the pharynx, just at the root of the tongue; over this part, which is termed the glottis, every morsel of the food must necessarily pass; yet, so exquisitely tender is the membrane of the windpipe, that the contact of the smallest extraneous body excites a convulsive paroxysm of coughing that does not cease until the offending matter be removed. Here then are two objects to be effected; the function of respiration requires that the windpipe should have a free communication with the external air, while the irritable nature of its membrane demands that no extraneous body should find admission. These points are both attained by means of a strictly mechanical contrivance; by a structure which produces the required effect, independently of the will of the animal, and merely in consequence of those motions which the organs perform in the office of deglutition. At the back of the tongue, and just in front of the glottis, is a cartilaginous valve called the epiglottis. When the parts are at rest, this valve stands perpendicular, and consequently does not interfere with the passage of air into the windpipe. In the act of swallowing, the tongue is carried backwards, and the windpipe is drawn up: hence the epiglottis becomes mechanically applied over the opening, and at this moment the food enters the pharynx over it, and by its pressure closes the aperture still more completely. As soon as the food has passed, the tongue and windpipe resume their former position, the elasticity of the cartillage restores it to the erect state, and the glottis is again free for the continuance of respiration. So completely does this simple mechanism answer the proposed end, that although every morsel of food passes over the glottis, the accident of any portion going the wrong way, as it is termed, is comparatively rare, and can only arise from our being imprudent enough to laugh or talk while we are swallowing. In either of these cases air must pass out of the trachea, and by so doing, it lifts up the epiglottis.

The pharynx opens below into the œsophagus, a muscular tube, which conveys the food into the stomach. The aliment in its farther progress, goes through different viscera contained in the abdomen; and we shall therefore proceed with a description of that cavity.

The term *abdomen* includes a large portion of the body. It is bounded above by the cartilages of the ribs, and by the diaphragm, which separates it from the chest; at the back part, by the bodies of the lumbar vertebra; in front and at the sides, by the abdominal muscles; and below, by the bones of the pelvis.

It is every where lined by a membrane called the peritoneum. The surface of this is perfectly smooth and polished, and moistened by a serous exhalation produced by the minute arteries of the part. This membrane not only lines the cavity of the abdomen, but also covers all the viscera contained in that cavity, so that the exterior surface of each part consists of what anatomists

call its peritoneal coat. Hence the motions of these parts upon each other, and upon the surface of the cavity are performed with perfect facility. The productions of the membrane, which give these exterior investments to the viscera, serve also to confine them in their relative positions.

The cavity is subdivided into three regions, the epigastric, which includes all the space above an imaginary line drawn across the belly, from the greatest convexities of the cartilages of the seventh true rib; the umbilical, which is the division between this line and another drawn from the anterior superior spines of the ilia; and the hypogastric, which is the space left below the last line.

The sides of the epigastric region, which are the spaces covered by the cartilages of the ribs, are called hypochondria: the sides of the umbilical region are named the loins: and those of the hypogastric the groins.

The stomach is a large membraneous reservoir, receiving the food from the œsophagus, and retaining it until a certain change, called *digestion*, is produced. Its figure is conical, as it is largest at the left end, and gradually decreases in size towards the right: these are called the greater and smaller extremities of the stomach. It is also bent in its course, so that we describe a greater and smaller curvature or arch. It has two openings, one close to the diaphragm, called the cardiac, superior, or œsophageal; the other just at the smaller end is called the pyloric, or lower orifice. The capacity of the stomach varies from about 5 to 11 pints.

Its structure is muscular; and this is necessary in order to propel the food when digested. Under the muscular coat is found the internal, or villous tunic, the arteries of which pour out the gastric juice, the chief agent in the digestion of the food.

The pylorus, which word is derived from two Greek terms, signifying the *keeper of the gate*, is a contracted ring, by which the stomach communicates with the small intestine. It prevents the food from passing out of the stomach, before it has been sufficiently acted on by the gastric juice.

The stomach receives a portion of peritoneum as the œsophagus passes the diaphragm. There is also a process coming from the liver, called the lesser omentum, or mesogaster. This is attached to the lesser arch of the stomach. The great omentum, or the caul, is affixed to the greater arch of the stomach, and hangs from thence over the surface of the intestines; being interposed between them and the intestines. It is also attached to a part of the colon; its use is unknown.

The small intestine is divided into three parts; the duodenum, jejunum, and ileum: but this distinction is an arbitrary one, and not founded on any difference in structure. It consists of a membranous tube, about an inch or an inch and a half in diameter, and four times the length of the subject. Notwithstanding this great length, it is collected by means of numerous turnings and convolutions, into a comparatively small space. These convolutions of the small intestine occupy the chief part of the umbilical and hypogastric regions of the abdomen. They are connected in their situation by means of a broad folded membrane, called the mesentery. This production of the peritoneum is about six inches broad at its commencement, but it expands gradually, something after the manner of a fan, so that it becomes broad enough, ultimately, to cover the whole length of the small intestine. It serves to keep the different convolutions of the canal in a certain relative position, and allows, at the same time, a considerable freedom of motion, without any danger of intangling. In tracing the course of the small intestine, we follow the duodenum from the lesser extremity of the stomach, in the right hypochondrium, making three turns close on the backbone, and then coming out just over the left kidney. The general direction of the canal from this point, independently of its various turnings and windings, is towards the right groin, where the ileum terminates by entering the cœcum.

The small intestine possesses three coats similar to those of the stomach: *viz.* an external or péritoneal; a middle or muscular; and an internal or villous tunic. The latter forms a great many transverse, loose, and floating processes, called valvulæ conniventes; by means of which the extent of surface of the villous coat is very much augmented. Numerous glandular bodies are found in parts of the canal, collected into small parcels, and hence called glandulæ agminatæ.

The food which is reduced by the action of the stomach into an homogeneous mass, called chyme, enters the small intestine, where it undergoes a further change, and becomes chyle. It is propelled along the canal by the muscular coat of the intestine, and the villous tunic absorbs from it the nutritious particles. It passes along every turn and winding of this long canal, continually subjected to the action of the absorbing vessels. The residue of the alimentary mat-

ter is sent into the large intestine, from which it is expelled in the form of fæces.

The large intestine is a canal of about two or three inches in diameter, and seven feet in length. It is divided into the cœcum, colon, and rectum. The cœcum is a bag situated in the right groin, and receiving the termination of the ileum. The latter intestine enters in such a manner that the passage of the aliment is allowed from it into the cœcum, but prevented from returning. The part which effects this is called the valvula coli. A small process, about equal in size to an earthworm, is connected to the cœcum. It is called appendix cœci vermiformis, and its use is unknown.

From the right groin the intestine ascends on the right side of the abdomen over the kidney, under the name of colon: it turns completely over the abdomen at the upper part, and descends along the left side to the left groin; here it makes a large turn over the brim of the pelvis, and enters that cavity, where it takes the name of rectum, which terminates at the anus. We distinguish in the colon, the right or ascending portion; the middle or transverse arch; the left or descending; and the sigmoid flexure. The right and left portions of this gut are closely bound down in their situations, by two portions of peritoneum, called ligamenta coli. The transverse arch has a broad process connected to it, by which it is loosely attached: this is called the mesocolon.

The large intestines have a peritoneal, a muscular, and a villous coat; but they have no valvulæ conniventes. The longitudinal muscular fibres are collected into three bands, which being shorter than the rest of the intestine, occasion the other coats to be gathered up in folds between them, and thereby give the intestine a sacculated appearance.

The residue of the alimentary matter, which the large intestine receives from the small, is converted in the former canal into a substance of peculiar odour, colour, and consistence, called fæces; in which form it is expelled from the body.

Parts subservient to the functions of the alimentary canal, and contained in the cavity of the abdomen.

The liver is the largest glandular mass in the body, and is placed towards the right side of the epigastric region. Its thickest portion fills the right hypochondrium; a thinner part of the gland extends across the middle of the epigastric region to the left hypochondrium. Its size is greater in proportion as the animal is younger. In the adult it is contained within the cartilages of the ribs; but in the fœtus it extends to the navel, and fills half the belly. Its upper surface is convex, and in close contact with the concave under surface of the diaphragm. Its under or concave surface rests chiefly on the stomach. It is divided into a right and left lobe, and lobulus spigelii. It has a posterior and thick, an anterior and thin margin. Its colour, in the most healthy state, is of a reddish brown; but it often deviates from this. Its weight, in an adult man of middling stature, is about 3 pounds. It is connected to the diaphragm by four ligaments: *viz.* 1. ligamentum latum, or suspensorium, which divides the right and left lobes from each other. The front edge of this part contains the fibrous remains of the umbilical cord of the fœtus, which assuming the appearance of a round rope, is called the round ligament. 2, 3. Ligamenta lateralia, or dextrum, et sinistrum. 4. Ligamentum coronarium.

The liver is covered exteriorly by peritoneum, and there are certain fissures and excavations on its surface. 1. Fossa, for the gall-bladder, in the under surface of the right lobe. 2. Fissure on the anterior, thin margin for the entrance of the umbilical vein. 3. Portæ, or large transverse notch, at which the blood-vessels enter, and from which the hepatic duct proceeds. 4. Notch for the inferior vena cava. 5. Excavation for the bodies of the vertebræ.

The liver is composed of a tolerably firm and close substance, consisting of a closely united congeries of different vessels. These vessels are the vena portarum, the hepatic artery, the hepatic veins, and the biliary ducts. The former vessel carries to the liver the blood which has circulated through the different abdominal viscera. It ramifies in the liver like an artery, and the secretion of the bile is supposed to take place from the blood, which it conveys to the liver. The blood of this vein, as well as that brought by the hepatic artery, for the nourishment of the liver, is returned by the large hepatic veins to the inferior vena cava. The small branches of the hepatic duct which conveys the secreted bile from the liver, appear like small yellow pores, when a section of the liver is made, and hence they are called pori biliarii.

The mesogaster or little omentum, is attached to the portæ of the liver. The vena portarum, the biliary ducts, the hepatic artery, and the hepatic plexus of nerves,

pass along the right side of this process; and the part in which they are situated is called the capsula Glissoni. Under the edge of this part is an opening, leading to the bag of the great omentum, and called the foramen epiploicum.

GALL-BLADDER AND BILIARY DUCTS.

The gall-bladder is a membranous bag, serving as a reservoir for the bile. Its shape is that of a pear, being broader at one end, and diminishing conically towards the opposite extremity. The broad end is called the fundus; and the smaller part the neck of the viscus. Its average capacity may be about one ounce. It is firmly bound to the surface of the liver by peritoneum. Its inner surface is elegantly reticulated, and furnishes a viscid mucus that mingles with the bile.

The hepatic duct is continued in a straight course from the liver to the duodenum, in which it opens. It passes, however, in an oblique manner, between the coats of the intestine, before opening into its cavity. Hence the contents of the intestine cannot enter the duct; and the more fully the intestine is distended, the more completely is this prevented by the compression of the duct between the intestinal tunics. The neck of the gall-bladder is gradually contracted into a small tube, called the cystic duct, which joins the hepatic at an acute angle, after first running parallel with it. The remainder of the hepatic duct after the junction with the cystic, is often called the ductus communis choledochus. The surface of the cystic duct, as well as that of the neck of the gall-bladder, has numerous small folds of the internal membrane, which must retard and obstruct the course of the bile.

Pancreas—Is a gland of the conglomerate kind; that is, composed of numerous minute portions, united by cellular substance. It is connected by one end to the commencement of the duodenum, and extends across the vertebræ, behind the lesser arch of the stomach, to the spleen. Its length is about six inches; its breadth one and a half; and its thickness half an inch.

Each of the small molecules which compose this gland, has an excretory duct; these unite together into larger and larger trunks, and the main tube of all runs along the centre of the gland, and joins the ductus communis choledochus just before that duct opens into the duodenum.

Spleen—This part, which in common language is called the milt, is a soft and livid mass interposed between the great end of the stomach and the diaphragm. It weighs about six or seven ounces. It consists of a congeries of cells filled with blood; as the arteries and veins of the organ communicate with them. It is closely connected to the great end of the stomach by vascular ramifications, which the splenic vessels send to the stomach. It has a concave and a convex surface; an anterior and posterior extremity; and an external peritoneal covering.

ORGANS OF RESPIRATION.

As these are contained in the cavity of the thorax, we shall consider the subject in the form of a description of that cavity and its contents.

The cavity of the thorax is the space included by the dorsal vertebræ behind, by the ribs with their cartilages, the sternum, and intercostal muscles, at the sides and forepart; and by the diaphragm below. This cavity is lined by a membrane called the pleura, which has a smooth internal surface constantly moistened by a serous exhalation.

The cavity of the chest contains two distinct membranous bags, called the right and left bags of the pleura; each of these holds the lung of its own side, and is entirely separated from the opposite one. The pleura not only forms a bag which holds the lung, but is also reflected over the surface of the viscus, bestowing on it a smooth exterior investment. This is called the pleura pulmonalis, to distinguish it from the other, which is named pleura costalis.

If the cartilages of the ribs be divided on one side of the chest, the corresponding bag of the pleura will be opened; and it will then appear, that this is separated from the opposite one by a partition, which extends from the sternum in front to the vertebræ behind, and is known by the name of mediastinum. The pleuræ may be compared to two bladders placed laterally with respect to each other, but adhering only partially, and separated by various intervening bodies. Thus, the heart and adjoining large blood-vessels, the œsophagus and the division of the trachea into the two bronchi, are placed between the two pleuræ. The mediastinum then is the space included between the opposed surfaces of the two bags of the pleuræ, and containing the parts above mentioned. The name of anterior mediastinum is applied to a small interval left between the two pleuræ, just behind the sternum, and occupied only by a loose cellular texture. The posterior mediasti-

num is a larger space in front of the bodies of the vertebræ; it contains the descending aorta, the vena azygos, thoracic duct, œsophagus, and the par vagum.

The capacity of the chest taken altogether varies according as we estimate it in a state of inspiration or expiration; being largest in the former, and smallest in the latter state. The right bag of the pleura is considerably larger than the left, as is also the right lung.

In the living state the lung is in close contact with the surface of the cavity, and follows all the motions of the sides of the chest. It is distended by the influx of air, when the chest is enlarged; and the air is expelled from the lung, when the chest is diminished. As soon as the thorax is opened in the dead subject, the lung falls down from the sides of the chest, or in technical language *collapses;* and then a large empty space is seen between it and the ribs. From this representation it should appear, that the lungs are quite passive in the business of respiration.

The lungs are two in number; one being contained in each bag of the pleura. They are loose and unconnected in these bags, except at one point, towards the upper and posterior portion of each viscus, where the great vessels enter them, and where the bag of the pleura is continuous with the reflected portion of the membrane. These are called the ligaments of the lungs.

Their colour varies considerably. It is always verging more to a red in proportion as the subject is younger; in the adult it has more of a spotted and livid cast. Towards the back of the lungs it is always much deeper from the gravitation of blood in the vessels in consequence of the position of the subject. It is lighter when the lungs contain much air.

The lungs are subdivided into lobes; of which the right contains three, and the left two. Their substance is composed of a congeries of minute membranous cells, about equal in size to a pin's head, and as these are more or less filled with air, they give the lung a peculiar spongy feel. These cells communicate with the ultimate ramifications of the air vessels, and receive air from that source. The pulmonary vessels ramify minutely in them, and thereby expose the blood to the effects of the contained air; and in this exposure the object of respiration is effected.

The windpipe. The tube, which conveys the external air into the lungs, may be divided into three parts; the larynx, the trachea, and the bronchi.

The larynx is a hollow cartilaginous organ, placed at the top of the trachea. The air which passes through this from the lungs, in expiration, produces the voice.

The cavity of the larynx opens above at the root of the tongue, and below into the trachea. The organ is composed of five pieces of cartilage: *viz.* the thyroid and cricoid cartilages, and epiglottis, and two arytenoid cartilages.

The thyroid cartilage is the largest, and consists of two irregularly quadrangular pieces, united in front at an obtuse angle. This part projects in the front of the neck, and much more conspicuously in the male than in the female sex: it is called pomum Adami.

The cricoid cartilage may be compared to a ring with a seal, of which the broad or seal part is placed behind, and the narrower portion in front. It is directly under the thyroid cartilage.

The arytenoid are two pyramidal portions of cartilage, connected by regular moveable articulations to the back of the cricoid.

The epiglottis is the softest cartilage of the larynx. It has a basis firmly tied to the thyroid cartilage; while its opposite extremity, which is very thin, is of a rounded figure, and stands directly upwards, except during deglutition, when it descends so as to cover the opening of the larynx.

The thyroid cartilage is tied by three ligaments to the os hyoides above, and by as many to the cricoid cartilage below: but the most important ligaments of these parts are the ligamenta glotcidis; which arise from the front of the arytenoid cartilages, and are attached to the posterior surface of the front portion of the thyroid. A longitudinal slit, called the rima glottidis, is left between these, and it is by the passage of the air through that slit that the voice is formed. Hence, from the great share which these ligaments have in forming the voice, the name of chordæ vocales has been given to them.

The larynx is lined by a vascular and very sensible membrane, copiously moistened with mucus, in order to defend it from the external air. It admits of free motion in the neck, and its parts are also moved on each other; particularly the arytenoid cartilages, whose movements, by altering the size of the ruina glottidis, and the state of tension of the chordæ vocales, contribute most immediately to the variations in the tone of the voice.

The trachea is that portion of the aerial

tube, which is placed between the cricoid cartilages, and the origin of the bronchi. It is a cylindrical membranous tube, of from 5 to $\frac{7}{8}$ths of an inch in diameter. It runs along the middle of the forepart of the neck, having the large blood-vessels of the head on each side, and being connected behind to the œsophagus. Soon after it has entered the chest, it divides into the two bronchi.

The tube of the trachea is furnished with hoops of cartilage, by which it is kept permanently open for the passage of the air: these are not however complete circles, being deficient behind. The lining of the tube is highly vascular and sensible, and covered with a copious mucous secretion, which is rendered necessary by the constant current of air to which it is exposed.

The bronchi are merely the two branches into which the trachea divides for the two lungs; and of these the right is the largest and shortest. They ramify through the lungs, dividing into smaller and smaller branches; and the ultimate ramifications communicate with the air-cells.

ORGANS OF CIRCULATION.

The heart is the centre of the circulating system; being the source of the arteries, and the termination of the veins. The younger the subject, the larger is the heart in proportion to the body. It is often smaller in tall and strong men, than under different circumstances.

It is connected at its posterior part, behind the sternum, by the large blood-vessels, being unattached every where else, and merely confined in its situation by the pericardium.

The pericardium is placed in the cavity of the chest, behind the second, third, fourth, and fifth ribs of the left side. It is covered to the right and left by the bags of the pleura, which adhere by a loose cellular membrane. It is not actually connected by any part of its surface to the sternum. Below, it rests on the diaphragm, and adheres very firmly to the superior surface of the tendon of that muscle.

The cavity of the pericardium is larger than the heart, so that this viscus can move freely in it.

The bag of the pericardium in shape resembles the figure of the heart itself, being conical. Its substance is thick and compact, and it is much more dense and strong than the peritoneum or pleura. Where the great vessels are connected to the heart, this membrane becomes reflected over its surface; and hence the substance of the heart has a close investment from this membrane, besides being contained loosely in the bag-like portion. A small portion of the large blood-vessels is included within the cavity of the pericardium; particularly of the aorta and pulmonary artery; which are consequently covered by the reflected portions.

The internal surface of the pericardium is moistened by a serous secretion from the exhalant arteries; which is collected after death into a few drops of a clear light yellow liquor. It is an unnatural increase of this that constitutes dropsy of the pericardium. This fluid in the living state lubricates the opposed surfaces of the heart and pericardium, and thereby facilitates their motion on each other, and prevents their accretion.

The heart, which is contained almost entirely in the left side of the chest, resembles a half cone; hence we distinguish in it a basis or broad part, and an apex or narrower portion; a convex and a flat surface. The basis is placed towards the right and backwards; the apex points obliquely to the left, forwards and downwards. The basis is opposite to the seventh or eighth vertebra of the back, and the apex points to the cartilage of the fifth or sixth left rib. The position however varies by the motion of the diaphragm in respiration, as it is drawn down in a strong inspiration, and again rises in expiration. Its position also seems to vary slightly, according to the situation of the body in lying.

A small portion of the left lung seems, as it were, removed just at the apex of the heart; so that that part of the viscus is not covered by the lung like the rest; but touches the front of the chest.

Those cavities of the heart which are called the right, are placed in front; and the left cavities are towards the back part; so that the epithets *anterior* and *posterior*, would correspond more nearly with the true position of these parts, than those of right and left.

The flat surface of the heart looks directly downwards, and rests on the tendon of the diaphragm; this, therefore, in point of position is inferior; the convex surface is turned upwards, forwards, and obliquely towards the left, so that it may be called the superior surface.

The weight of the human heart, when removed from the body, with its pericardium, is from 10 to 15 ounces.

Like the heart of all warm-blooded ani-

mals, this organ consists of two hearts, closely and intimately connected. One of these is concerned with the circulation through the body, or the greater circulation; the other with the circulation through the lungs, or the minor circulation. These might perform their offices if separate and even distant from each other. Each of these hearts consists of two cavities; an auricle, or membranous bag, placed at the mouths of the veins; a ventricle, or strong muscular organ, placed at the orifice of the artery, and constructed for the purpose of driving the blood into that vessel and its branches.

The two auricles are placed at the basis or broadest part of the heart; and the two ventricles composing the chief bulk of the organ, are found in front of the former cavities.

In the following description of the structure of the heart, we shall trace the parts in the same order in which the blood passes through them. This fluid, then, after circulating through the blood-vessels of the body, after serving the various purposes of nutrition, secretion, &c. is returned into the right auricle of the heart by three large veins, *viz.* the superior and inferior vena cava, and the great coronary vein. The properties of this blood have been so altered in its course, that it is necessary for it to be subjected to the action of the atmosphere in the lungs, before it is again fit to be sent into the arteries of the body. The right auricle derives its name of auricle from a small fringed process, which is found at its anterior part; the rest of the cavity is called the sinus of the venæ cavæ. The lining of this bag, as indeed that of all the other parts of the heart, consists of a smooth and polished surface. The muscular fibres of the auricle are not numerous nor large; they are arranged in parallel fasciculi, which have been compared to the teeth of a comb; and hence the epithet of musculi pectinati has been given to them.

The right auricle transmits the blood into the right, anterior, or pulmonary ventricle, through a large circular orifice, called the annulus venosus, or the auricular orifice of the ventricle. When this latter cavity contracts, the blood would be driven back towards the auricle, were not this prevented by a valve, called the tricuspidal or triglochine. This valve is formed by a production of the lining of the heart, divided into three pointed portions. These are tied by tendinous strings to certain projecting packets of the muscular fibres, called the fleshy columns of the ventricle. The structure of the ventricle is very different from that of the auricle. It is a strong muscular cavity, adapted to the office of forcibly projecting the blood through the arterial ramifications; whereas the auricle is a mere reservoir, holding the blood until the ventricle has emptied itself by its contraction.

The pulmonary artery, which arises from the upper and anterior part of this ventricle conveys the blood into the lungs. The opening of this artery, which is called the arterial orifice of the ventricle, is furnished with three valves, called sigmoid or semilunar, which prevent any retrograde motion of the blood from the artery towards the heart.

The venous blood, by being exposed to the atmospheric air in the lungs, is altered in its properties, and becomes arterial blood, in which state it is returned to the left auricle of the heart by four pulmonary veins, two of which belong to each lung. This left or posterior auricle consists of a large cavity, called the sinus of the pulmonary veins; and of a smaller process or auricula. It is situated quite at the upper and back part of the heart, and transmits the blood through the auricular orifice of the left ventricle into that cavity. This opening is perfectly similar in all essential circumstances to the corresponding part on the right side of the heart. But its valve, being divided into two portions only, is called mitralis, from a comparison with a bishop's mitre.

The left ventricle is much thicker and stronger than the right. It feels externally almost like a solid mass of flesh; while the right is comparatively thin and flabby. The reason of this difference is obvious. The left ventricle has to drive the blood to the most remote parts of the body; whereas the right only sends it through the lungs. The aorta arises from the left ventricle, and its mouth is guarded by three semi-lunar valves. This is the trunk from which the arteries of the whole body arise.

STRUCTURE OF THE ARTERIES.

Those vessels, through which the blood flows from the heart into every part of the body, are called *arteries*. The term, which is derived from αηρ, air, and τηρεω, I hold, was first adopted by the anatomists of the Alexandrian school, in consequence of the erroneous opinion which they entertained, that these vessels were designed for the distribution of air throughout the body.

The larger arteries have thick and elastic

sides, so that they remain open when divided, and present a regularly circular aperture. The sides may be separated into three strata of dissimilar substances, which are technically called coats. The innermost, which is generally termed the cuticular coat, is very thin, but strong and inelastic. Upon this circumstance depends the regularly circular form of an injected artery; for if the cuticular coat be burst from the employment of too great a force in injecting, the exterior tunics are distended into an irregular and uncertain figure. The internal surface of this coat is perfectly smooth, so that the blood glides along it without impediment; the external surface is connected to that coat, which surrounds it. The middle, or, as it is called, the muscular coat, is composed of a congeries of circular fibres, separable into numerous strata, but not much resembling muscular fibres as found in other situations. The external, or elastic coat of the artery, is made of condensed cellular substance; it is powerfully elastic; and is resolved into a looser texture, which unites these vessels to the neighbouring parts.

It appears that the larger vessels have the greatest elastic power, with the smallest muscular force; while these properties exist in reversed proportions in the smaller vessels. In the large arteries muscular power is unnecessary, for the force of the heart is fully adequate to the propulsion of the blood; but in the smaller arteries, where the effect of the heart's action declines, a proportionate muscular power is allotted to the vessel to urge on the circulating fluids.

The arteries have their nutrient arteries and veins, their absorbents, and their nerves.

All the arteries proceed from one great vessel, as the branches spring from the trunk of a tree; and we proceed to notice certain circumstances observable in their ramifications.

1. When an artery gives off a branch, the conjoined areas of the two vessels make a greater space for the blood to move in, than the area of the original vessel. The increase of dimensions in the branches of a large artery is slight; but in those of a small one it is so considerable, that Haller has estimated it as surpassing by $\frac{1}{3}$d that of the trunk from which they sprung. The conjoined areas of all the small arteries so greatly exceed that of the aorta, that the same anatomist, in opposition to former opinions, affirms that these vessels are conical, the basis of the cone being in the extreme arteries, and the apex in the heart.

2. When a large artery sends off a branch, its course does not, in general, deviate further from that of the trunk than an angle of 45 degrees. Sometimes a branch, which has gone off at an acute angle, returns, and proceeds in a contrary direction to that of the trunk. Sometimes indeed a large artery does proceed from the trunk at nearly a right angle, as the renal arteries. Though the large arteries generally ramify at acute angles, there is great diversity in the branching of the smaller ones.

3. Arteries in general do not pursue a straight, but a serpentine course; this is remarkably the case in some instances; as in the spermatics; those of the face and occiput, and in most of the smaller arteries.

4. Though the ramification of arteries may be compared to the branching of trees, yet it differs materially in this particular, that the different branches frequently conjoin. This conjunction is technically termed, if we borrow the term from the Greek language, their *anastomosis;* if from the Latin, their *inosculation.* This union of arteries rarely happens among the larger ones, but frequently among the smaller; and increases in number in proportion to the minuteness of the vessels. The utility of the inosculations of arteries is evident; were it not for this circumstance, if any arterial trunk were accidentally compressed, so that the current of blood in it should be for some time obstructed, the parts, which it supplied, must perish. But in consequence of the frequent communications of these tubes with each other, the blood can pass from the adjacent arteries into all the branches of any one accidentally obstructed.

When arteries inosculate, two currents of blood, moving in opposite directions, must come together, and retard each other's motion. This probably is the reason, why larger arteries, in which the blood flows with rapidity, so seldom conjoin; whilst the smaller ones, in which the blood's motion is more tardy, communicate in surprising numbers, and with a frequency proportionate to their minuteness. The very frequent communications of the minute arteries prevent the prejudicial consequences of obstruction of the trunks almost as effectually, as if those arteries themselves communicated by more direct and larger channels.

All these minute arterial tubes are capable of enlargement; and it is an ascertained

fact, that even the aorta itself may be gradually obstructed at some distance from the heart, without the parts which it supplies being deprived of nourishment. From an attentive consideration of all these circumstances, it has been concluded, that the moderate increase of the area of the branches of large arteries; the acute angles at which they divide; their nearly rectilinear course; and the rare occurrence of inosculation between them, are designed to facilitate the rapid motion of the blood in them, so that it may arrive unchanged, and in the same state that it was in when projected from the heart, at that part of the body, for the nourishment of which it was intended: whilst, on the contrary, the great increase of the area of the smaller vessels, the variety of their angles, their tortuous course, and their frequent communications were designed to check the velocity of the blood's motion, when it has arrived at that part, where secretion is to be performed, and nutrition is to take place. Contrary opinions have indeed been maintained; and for the further discussion of this subject, we must refer the reader to the remarks on the *circulation* in the article PHYSIOLOGY.

Termination of the arteries.—When these vessels have become very minute, they terminate in two ways: they either turn back again, and become veins, and return the blood to the heart, or they send off fine vessels, which abstract something from the circulating blood, and are therefore called secerning arteries. Though none but minute arteries are ever reflected to become veins, yet many of them are of sufficient magnitude to admit common waxen injection: and when this experiment succeeds, the continuity of the arteries and veins is very manifest. It seems therefore to follow from this facility of communication, that the mass of the blood is constantly and freely circulating, in order to undergo that change, which is effected in the lungs, whilst but a small part of it proceeds into the very minute arteries, for the purpose of having secretions made from it. For these arteries, however minute, must be considered large in comparison with the exility of others, which cannot be injected with wax, and even reject the red globules of the blood, or admit them in such small proportion, that they do not impart the red colour to the fluid, which moves in those vessels. Now, we may venture to affirm, that these globules do not much exceed in diameter the 150,000th part of an inch, which circumstance sufficiently shews the minuteness of the lesser arteries.

The secerning arteries are in general too minute to admit of demonstration; they are however evident in some glands; in the kidney, for instance, they may be seen continued into the excretory vessels. Subtile injections, when thrown into the larger arterial trunks, ooze out on the surfaces of membranes, and into the cellular substance, and they are generally supposed to be poured forth from the open orifices of secerning arteries. Analogy therefore, rather than actual demonstration, leads us to believe, that the secerning arteries abstract the particles of nutrition, or the materials which compose the fabric of the body, from the circulating fluids, and deposit them from their open mouths, so as by this means to build up and keep in repair the structure of the body.

Distribution of the arteries.—The great artery, whose branches supply the whole of the body, is named the *aorta*. It arises from the upper part of the left ventricle; and emerges from the heart, between the pulmonary artery and the right auricle. It first ascends in the chest; opposite the upper edge of the second rib it bends backwards till it reaches the left side of the spine, in which situation it descends from the fourth or fifth dorsal to the last lumbar vertebra.

By the arch of the aorta is meant that part of the vessel, which arises from the heart, and bends across the chest. It sends off the following branches: the two first arising at right angles close to the heart; the three following from the convexity of the arch:

1. Right coronary artery of the heart.
2. Left coronary artery of the heart.
3. Arteria innominata, a common trunk, dividing into
    1. Right subclavian.
    2. Right common carotid.
4. Left common carotid.
5. Left subclavian.

The common carotid artery is destined for the supply of the head. It emerges from the chest by the side of the trachea; mounts upwards in front of the vertebræ, and parallel with the trachea, till it reaches the upper margin of the thyroid cartilage, without sending off a single branch. At this part it divides into the external and internal carotid arteries, the former of which is distributed to the outside of the head; the latter to the brain.

The external carotid continues its course upwards between the jaw and the ear, being imbedded in the substance of the parotid gland.

Branches of the external carotid artery.

1. Superior thyroideal.
   a. Laryngeal branch.
2. Lingual artery.
   a. Hyoideal branch.
   b. Artery to the back of the tongue.
   c. Raminal artery.
3. Facial or labial, or external maxillary.
   a. Ascending palatine branch.
   b. Arteries to the surrounding glands.
   c. Inferior labial artery.
   d. Coronary artery of the lower lip.
   e. Coronary artery of the upper lip.
   α. Nasal arteries.
4. Ascending pharyngeal artery.
5. Occipital artery.
6. Posterior artery of the ear.
7. Superficial temporal artery.
   a. Branches to the parotid gland.
   b. Anterior auricular arteries.
   c. Transverse artery of the face.
   d. Middle temporal artery.
   e. Anterior temporal branch.
   f. Posterior temporal branch.
8. Internal maxillary artery.
   a. Middle artery of the dura mater, or spinous artery.
   b. Inferior maxillary artery.
   c. Pterygoid branches.
   d. Deep temporal branches.
   e. Artery of the cheek.
   f. Alveolar artery of the upper jaw.
   g. Infra-orbital artery.
   h. Superior palatine branch.
   i. Nasal branch.

The internal carotid artery enters into the skull through the canal formed in the substance of the temporal bone. And its branches ramify through the substance of the brain. All the arteries of the brain have thinner coats than these vessels possess in any other part of the body.

Branches of the internal carotid artery.

1. Ophthalmic artery, supplying all the parts contained in the orbit.
   a. Lacrymal branch.
   b. Ethmoidal arteries.
   c. Superior and inferior muscular branches.
   d. Central artery of the retina.
   e. Ciliary arteries.
   f. Superior and inferior palpebral branches.
   g. Nasal artery.
   h. Frontal artery.
2. Communicating branch.
3. Anterior artery of the brain.
4. Middle artery of the brain.

The subclavian artery passes over the first rib, and behind the clavicle, into the cavity of the axilla. There it takes the name of *axillary*, and is covered by the pectoral muscles. Emerging from the armpit, its name is again changed for that of *brachial*. This part of the trunk runs along the inside of the arm, close to the edge of the biceps muscle, until it reaches the elbow joint, where it divides into the branches that belong to the fore-arm.

Branches of the subclavian artery:

1. Internal mammary.
2. Inferior thyroideal.
   a. Thyroid branch.
   b. Ascending thyroid artery.
   c. Transverse artery of the neck.
   d. Transverse artery of the shoulder, or supra scapulary.
3. Vertebral, a large trunk passing through perforations in the transverse processes of the cervical vertebræ, and through the foramen magnum of the skull to the brain, where it unites with its fellow of the opposite side, to form the basilar artery.
   a. Inferior artery of the cerebellum.
   b. Arteries to the spinal marrow.
   c. Superior artery of the cerebellum.
   d. Posterior or deep-seated artery of the brain.

N. B. The arterial circle of Willis is a large anastomosis; by which the two carotids are joined together, and united also to the basilar artery.

4. Superior intercostal.
5. Deep-seated cervical artery.
6. Superficial cervical artery.

Branches of the axillary artery.

1. Superior or short thoracic.
2. Inferior or long thoracic.
3. Thoracic artery of the shoulder.
4. Deep thoracic artery.
5. Infra-scapular artery.
6. Posterior circumflex.
7. Anterior circumflex.

Branches of the brachial artery.

1. Various muscular branches.
2. Profunda humeri major, or greater deep-seated artery of the arm.

3. Medullary artery of the humerus.
4. Lesser deep-seated artery of the arm.
5. Great anastomozing branch.
6. Radial artery.
7. Ulnar artery.

The two last branches are those into which the trunk of the brachial divides at the elbow. They run along the fore-arm to the wrist.

Branches of the radial artery.

1. Recurrent branch.
2. Superficial artery of the palm.
3. Branch to the back of the wrist.
4. Branches to the back of the thumb and fore-finger.

The artery then enters the palm, and forms the deep-seated arterial arch of the palm.

Branches of the ulnar artery.

This vessel, when it has arrived at the wrist, passes forwards into the palm of the hand, more superficially than the radial, and forms the superficial arch of the palm.

1. Recurrent artery.
2. Interosseous artery.
    - a. Posterior branch.
        - α. Interosseous recurrent.
    - b. Anterior branch.
3. Branch to the back of the hand.
4. Deep palmar branch.
5. Three large digital arteries.

Branches of the descending portion of the aorta in the chest.

1. Common bronchial artery.
2. Right and left bronchial arteries.
3. Esophageal arteries.
4. Lower intercostal arteries.

The aorta passes through the diaphragm at the lower part of the chest, and takes the name of abdominal aorta. It is still situated on the left side of the bodies of the vertebræ, and at the fourth lumbar vertebra it terminates by dividing into the two common iliac trunks.

Branches of the abdominal aorta.

1. Right and left phrenic arteries.
2. Cæliac artery.
    - a. Coronary artery of the stomach.
    - b. Hepatic artery.
        - α. Duodeno-gastric, or gastro-epiploic artery.
        - β. Superior pyloric artery.
        - γ. Cystic artery.
    - c. Splenic artery.
        - α. Pancreatic arteries.
        - β. Short arteries to the stomach.
        - γ. Left gastro-epiploic artery.
3. Superior mesenteric artery.
    - a. From 12 to 20 large branches to to the small intestine.
    - b. Middle colic artery.
    - c. Ileocolic artery.
4. Renal, or emulgent arteries.
5. Spermatic arteries.
6. Inferior mesenteric artery.
    - a. Left colic branch.
    - b. Internal hemorrhoidal branch.
7. Five pairs of lumbar arteries.
8. Two common iliac arteries.
9. Middle sacral artery.

The common iliac quickly divides into the external and internal iliac branches, of which the former goes to the thigh, the latter enters the cavity of the pelvis.

Branches of the internal iliac artery.

1. Ileo-lumbar artery.
2. Lateral sacral arteries.
3. Vesical arteries.
4. Middle hemorrhoidal.
5. Uterine branch.
6. Obturator artery.
7. Gluteal artery.
8. Ischiatic artery.
9. Pudendal artery.
    - a. External hemorrhoidal branches.
    - b. Artery of the perineum.
    - c. Dorsal artery of the penis.
    - d. Deep artery of the penis.

The external iliac artery, having changed its name for that of femoral, runs along the front of the thigh, and then bends inwards to the ham, where it takes the name of popliteal. It passes through the latter space to the leg, when it terminates by dividing into two, of which one runs along the front, and the other the back of the leg.

Branches of the external iliac artery.

1. Epigastric artery.
2. Circumflex artery of the ilium.

Branches of the femoral artery.

1. Branches to the lymphatic glands, and integuments.
2. External pudic arteries.
3. Deep-seated artery of the thigh.
    - a. External circumflex artery.
    - b. Internal circumflex artery.
    - c. First and second perforating branches.
4. Branches to the neighbouring muscles.
4. Great anastomosing branch.

Branches of the propliteal artery.

1. Superior internal articular artery.
2. Superior external articular artery.
3. Middle articular artery.
4. Inferior internal articular artery.
5. Inferior external articular artery.
6. Anterior tibial artery.
7. Posterior tibial artery.

Branches of the anterior tibial artery.

1. Recurrent branch.
2. Various small muscular branches.
3. External and internal malleolar arteries.
4. Tarsal and metatarsal arteries.
5. Dorsalis hallicis.

Branches of the posterior tibial artery.

1. Large muscular branches to the soleus.
2. Medullary artery of the tibia.
3. Peroneal or fibular artery.
   - *a.* Anterior branch.
   - *b.* Posterior branch.
4. External plantar artery.
   - *a.* Four digital arteries.
5. Internal plantar artery.

There is another large arterial trunk in the body, besides the aorta, called the pulmonary artery; this rises from the right ventricle, and conveys the venous blood to the lungs, for the purposes of respiration.

OF THE VEINS.

The blood is constantly moving in the arteries from the trunks into the branches; in the veins it follows a directly opposite course, and flows from the branches to the trunks.

There are seven large venous trunks in the body, to which all the blood is returned: three of these, *viz.* the superior and inferior vena cava, and the coronary vein of the heart, return the blood, which has circulated through the body into the right auricle of the heart: the other four are the pulmonary veins, and bring the blood back from the lungs to the left auricle.

The coats of the veins are thin when compared with those of the arteries; hence the blood can generally be plainly seen through them; and hence when divided they collapse, instead of presenting a circular section, as arteries do. It is difficult to separate them into coats, yet they are said to consist of two; *viz.* a smooth and highly polished internal one, which lines the canal; and a rough, cellular, external tunic, in which no muscular power resides. Hence the circulation proceeds through these vessels merely by the impulse of the arterial blood, and is not aided by any action of the containing tubes.

The veins are much more numerous, and also larger than the arteries. In most parts of the body each artery has two veins lying by its side; and in many instances there is another numerous set of veins besides these. Hence the venous system is much more capacious than the arterial; and this difference is so great, that the veins are supposed to contain nine parts out of thirteen of the whole mass of blood. This great capacity of the venous system obviates the effects of any casual obstruction to the ready transmission of blood through the lungs; for the whole of the veins are not distended in a natural state, but serve as an occasional reservoir, in which the blood, constantly urged forwards by the heart, may be held till the cause of obstruction has ceased. But as such retardation in the course of the venous blood would tend to drive back the whole mass on the minute veins, which are the least able to bear it, such retrograde motion is prevented by valves, which exist in great numbers in the venous system. These are thin membranes, having a semilunar edge attached to the side of the vein, and a straight edge floating in the cavity of the vessel: they are placed in pairs. When the blood is going on in its natural direction, they lie close to the sides of the tube; but, when it attempts to return, the blood raises the loose edge, and that meets in the centre of the vessel with the corresponding part of the opposite valve, and thus closes the canal. Thus, when an obstruction takes place, each portion of a vein has to support that column of blood only which is contained between its own valves. Still, as these vessels possess no powers of their own, and are too far removed from the heart to feel its influence on the passage of blood through them, we find that the circulation is affected in them by external causes, as position, &c. Hence the legs swell after long standing; and hence also the veins of these parts are apt to become enlarged and varicous.

Distribution of the veins.—This is for the most part similar to that of the arteries, as each of the latter vessels have generally two accompanying veins, (which bear the same names as the concomitant arteries) named venæ sodales arteriarum. But in some situations there is a class of veins not corresponding to the arteries, but running under the skin, and termed cutaneous or superficial

veins. These are found particularly in the extremities, and vary much in size at different times.

The vena cava superior is formed by three large trunks.

1. Vena azygos, which returns the blood from the sides of the chest, and runs along the middle of the spine.

2. Right subclavian, which is also made up by three venous trunks, *viz.* the internal jugular, the external jugular, and the axillary.

3. Left subclavian, formed in the same manner as the right.

The external jugular vein returns the blood from the outside of the head, and runs along the neck, just under the skin. We sometimes bleed from this in affections of the head.

The internal jugular is a very large vessel, lying deeper in the neck, and close to the carotid artery. It brings back the blood from the brain. The danger in attempts at suicide consists in dividing this vessel or the carotid artery, and not the external jugular vein. The axillary vein is made up of the vessels which bring the blood back from the arm. Besides the deep-seated veins, we have here a large superficial vessel, running along the outside of the fore-arm and arm, and called the cephalic vein; another on the inside, named the basilic. Between these in the fore-arm are found some veins called the median. At the bend of the elbow these last make up two large trunks, of which one opens into the basilic, and the other into the cephalic vein. These are called vena mediana basilica, and vena mediana cephalica. It is in the latter veins that we generally bleed when that operation is performed in the arm; and as they run directly over the artery, the latter vessel is endangered by the lancet.

The inferior vena cava is a very large trunk, running along the spine at the right side of the aorta. It returns the blood from all the lower parts of the body. It is made up by the junction of the two common iliac veins; and as it ascends through the abdomen, it receives the following venous trunks: the lumbar, spermatic, renal, and the immense venæ cavæ hepaticæ.

The common iliac vein is formed by the junction of the external and internal iliacs. The latter brings back the blood from the cavity of the pelvis; the former returns it from the lower extremity.

We have two large cutaneous veins to notice in the leg and thigh; *viz.* the saphena major, which runs up along the inner side both of the leg and thigh, and can be distinctly seen in the living person when in the erect posture; the saphena minor, which runs over the calf of the leg. The former terminates in the femoral vein, near the abdomen, the latter in the popliteal vein.

The vena portarum is a large vessel formed by the union of those veins which belong to the stomach and intestines, the spleen and pancreas. It conveys the blood, which has circulated through those organs, to the liver, and it branches out in that gland as arteries do in other parts. Its blood is returned from the liver by the hepatic veins, which have been already noticed.

ORGANS OF ABSORPTION.

The absorbents are a minute kind of vessels found in animal bodies, which attract and imbibe any fluid that is brought near their mouths. They are so minute and transparent, as not to be discovered in ordinary dissection; but by great labour they have at length been detected in great numbers in every tribe of animals. As these vessels are transparent, their contents are visible, which circumstance occasioned them to receive the different denominations of lacteals and lymphatics. The former were so called, because they imbibed the chyle, a milky fluid, from the bowels; whilst the latter, containing much lymph, which they had taken up from all the interstices of the body, were therefore named lymphatics. The discovery of this system of vessels is referred to the seventeenth century. But at first their number did not appear sufficient to perform the whole function of absorption; neither had they been discovered in birds or fishes, whence anatomists still retained the idea that the veins participated in this important office. The merit of first demonstrating the absorbing vessels in those animals belongs to Mr. Hewson, who assisted in the labours of the first eminent anatomical school in London, where anatomy was most ably taught by Dr. Hunter. And it is to the immortal Hunter that we are indebted for fully proving the important doctrine, that the whole business of absorption is performed by the vessels which we are now considering. They have of late been injected in such great abundance, that they appear fully adequate to perform their office.

If, as we firmly believe, these vessels be the only ones which perform the office of absorption, they must exist in every part

of the body. For there is no spot on the surface of the skin from which ointment may not be taken up, nor any internal part from which blood, when accidentally effused, may not be absorbed; nay, the very matter composing the texture of our bodies, is undergoing continual removal and renovation. These vessels must therefore be supposed to begin by open orifices generally throughout the body, although the fact can be demonstrated in the intestines only. On the inner surfaces of these organs they appear to the unaided eye fine and pointed tubes; but by the microscope their mouths are discerned to be patulous, and like a cup. The beginning absorbents soon join together, and after some time form minute vessels, capable of being injected by anatomists: these again conjoin, and form larger vessels, which are still discoverable with great difficulty.

In structure and arrangement these vessels have great similitude to veins: they have in consequence been named by some anatomists the lymphatic veins. Like the veins, their sides are thin and transparent, though of considerable strength: like the veins, they frequently communicate together, or, as it is technically termed, anastomose. The advantage derived from these communications is obvious: for by these means the dissimilar matters which they take up from various parts are mixed together, and blended with the lymph which they imbibe from the interstices of the body, and which serves as a vehicle for such heterogeneous particles; they also prevent accidental pressure made on a few vessels from obstructing the progress of the absorbed fluids, which are in that case conveyed forwards by collateral channels. Like the veins also, these tubes, by conjoining, form a tube of smaller area than the united areas of the vessels before their junction. The effect of this construction is the same as in the veins; that is, an acceleration in the currrent of the lymph in proportion as it comes nearer to the trunk of the absorbing vessels. The diameter of the thoracic duct bears but a small proportion to the united diameters of all the minute absorbents in the body, and when this duct has been opened, the lymph has flowed from it with a force and jet like that with which the blood issues from a large vein. Like the veins, the absorbents are furnished with numerous valves, which prevent any retrogade motion of their fluids, and also prevent any portion of the vessel from sustaining the weight of more fluid than is contained between its valves. The absorbents, however, differ from the veins in one very material circumstance, *viz.* that they have a power of contraction, and are able of themselves to propel their contents. Whoever reflects on the phenomena of absorption, can scarcely doubt that these vessels have a contractile power, by which they refuse admission to noxious substances, whilst they readily imbibe those that are salutary. If these vessels are observed in the mesentery, when turgid with absorbed chyle, their contents will disappear in a certain tract, and again become visible; a phenomenon that can only be explained by supposing the vessel to contract at that part, and urge forwards its contents. Haller found that the thoracic duct contracted when stimulated, so that there can be little doubt of these vessels being muscular throughout their whole extent.

The absorbents are found in considerable numbers under the skin of the extremities; and, when they arrive at the groin and armpit, they pass through little bodies about the size of small beans, which are called lymphatic glands. The absorbent vessels, as they approach the gland, generally separate into several branches, which terminate in that body: and again, about an equal number of absorbents emerge from the gland, conjoin, and form one or more principal absorbing vessels. The absorbents, which enter the gland, are usually denominated vasa inferentia, and those, which go out of it, vasa efferentia. If quicksilver be poured into the former vessels, the gland swells, and a great deal of quicksilver appears to be deposited in it; and afterwards, if the power propelling the injection be continued, it is seen coming out of the gland, by the vasa efferentia. It seems therefore to follow, that the progress of the absorbed fluid is checked a little in these glands, and it is probable, that some change is effected in its progress through them. This opinion is confirmed by observing, that these glands abound with blood-vessels, which probably pour some fresh animal juices into those which are contained in the lymphatic vessels.

The lymphatic glands are found in great numbers in the groin, armpit, and side of the neck, apparently serving like barriers to the absorbents of the head and extremities, as they approach to the large veins of the trunk. The absorbents of the intestines, which contain the chyle, a scarcely

animalized fluid, sometimes pass through three or four sets of glands, before they arrive at the thoracic duct; hence they are called lacteal vessels primi, secundi, tertii, or quarti generis. The place where the lacteals conjoin, and meet with the lymphatics from the lower parts of the body, to form the thoracic duct, appears in animals like a reservoir, and has been named the receptaculum chyli. The vessel thus formed, penetrates the diaphragm, in conjunction with the aorta, and is called the thoracic duct. In this situation it lies close on the back bone, between the vena azygos and the aorta. Towards the neck, it leaves the bone to reach the left subclavian vein, into which its contents are poured; the absorbents of the left arm and side of the head having previously joined it. The passage of blood from the vein into the duct is effectually precluded by means of valves.

The absorbents of the right arm and side of the head form a smaller trunk on the right side, which opens into the corresponding part of the right subclavian vein.

Thus all the old materials of the body, which the absorbents are continually removing, all the new matter imbibed from the surface, all the redundant lymph taken up from the interstices of the body, and all the chyle occasionally obtained from the bowels, are conveyed into the large veins near the heart. It is, in short, chiefly by this system of vessels, that the blood is augmented in quantity, or altered in quality; they replenish the body with nutriment, and occasionally taint it with infection.

It is sufficient to inform the reader, that these vessels exist in great numbers in all parts of the body, without entering into any detailed description of their particular distribution. We may just observe, that the course of these vessels, and their entrance into glands, become occasionally demonstrated in disease. When irritated by any local mischief, they form red streaks, manifest on the surface of the body; and the irritating or poisonous nature of the matters, which they imbibe, causes swelling and inflammation of the glands, in which this matter is deposited. Thus the glands in the groin swell from the absorption of venereal matter; those in the axilla become affected in cancer, and in the inoculation for the small pox.

OF THE URINARY ORGANS.

The urine is secreted in two large glands, called the kidnies. These are situated behind the peritoneum, in that part of the abdomen, termed the lumbar region, where they are surrounded by a quantity of loose cellular and adipous substance. Their form resembles pretty exactly that of the kidney bean. There seems to be a small part as it were scooped out, opposite to the bodies of the vertebræ; at this, which is called the notch of the kidney, the blood-vessels enter.

When we make a cut through the substance of this organ, it is found to be made up of two substances, differing in appearance. The exterior is called the cortical or arterial part, the interior, which consists of several conical portions, is named the uriniferous. The latter remains perfectly white, if a kidney be injected. Several very minute converging tubes are seen running through the uriniferous portion, and terminating by open mouths on their conical points; these, which can be filled with minute injection from the arteries, and the open mouths of which can be seen with the aid of a small magnifying power, are the excretory tubes, or tubuli uriniferi, of the kidney. The uriniferous portion of the gland forms about fifteen conical projections, termed papillæ; on each of which the excretory tubes open in great numbers. The papillæ project into short membranous canals, called infundibula; and these terminate in a common receptacle, situated at the notch of the kidney, and known by the name of the pelvis. From this, a canal about equal in size to a writing quill, the ureter, conveys the secreted fluid into the bladder.

The bladder is a membranous and muscular reservoir, receiving the urine as it is found in the kidneys, retaining it until it has accumulated in some quantity, and then expelling it through a canal, called the urethra.

The internal surface of the bladder is formed by a smooth membrane, constantly covered with a mucous secretion, which defends it from the irritating effects of the contained fluid. It has a muscular coat, sometimes described as a muscle, under the name of detrusor urinæ; and that part of the fibres, which is situated round the opening of the urethra, is called the sphincter vesicæ, as it keeps the aperture constantly closed until we make an effort for the expulsion of the contained fluid. The ureters open into the lower part of the bladder; and open in such a manner, that, although the urine flows readily from them into the receptacle, none can return. They

pass between the muscular and internal tunics, before they penetrate the latter.

The bladder is situated just behind the ossa pubis; and is partly covered by the peritoneum. The urethra proceeds from its lower and anterior surface, and this part is called the neck of the bladder; it then goes under the arch of the pubis. It forms in the female a canal about an inch and a half, or two inches long, which opens in the cavity, left between the labia pudendi. In the male it is about nine inches in length, and runs along the under part of the penis to the extremity of that organ, where it opens.

ORGANS OF GENERATION.

The parts which the two sexes perform, in the important business of propagating the species, are so entirely different, that we shall not be surprised at finding that the male and female organs of generation are wholly dissimilar to each other.

The germs or rudiments of the future beings are produced by the female, in organs called the ovaria. But these remain inert and useless, unless called into action by the fecundating influence of the male. The fecundating fluid is prepared in two glands, called the testes. When the germ has been acted on by this fluid, it passes through a canal called the fallopian tube, into the uterus, where it is retained until it has acquired a considerable magnitude; and from which it is expelled at the end of nine months. The seminal liquor of the male is poured into the urethra, and is introduced by means of the penis into a membranous cavity of the female, called the vagina.

External parts of generation in the female. Over the surface of the pubis, there is a greater accumulation of fat and cellular substance, than in the male; and the prominence caused by this structure is called mons veneris. A longitudinal cavity extends from this eminence in front to the anus behind; and the sides of it are bounded by two folds of the skin, called labia pudendi, or alæ majores. The whole of these parts taken together constitute the pudendum, or sinus pudoris. The mons veneris, and the outer surface of the labia, are covered with hair to a greater or less extent.

The parts contained within this longitudinal cavity are covered by a more delicate kind of integments, than that which composes the general surface of the body. A change takes place in the organization of the skin, somewhat similar to that which is observed at the lips. Hence the surface of the parts contained within the labia has a red, smooth, and soft covering; which is besmeared with a sebaceous secretion of peculiar odour, furnished by numerous small glands, lying just under the surface. This unctuous matter is required in order to defend the parts from the urine; and also to obviate the effects of that rubbing on each other, which must be occasioned by the motions of the body.

Towards the upper part of the longitudinal slit, left between the labia, a small prominent organ is discerned, called the clitoris. This exactly resembles the male penis in structure. It only projects however, about a quarter of an inch. We distinguish in it a glans and preputium, which resemble, on a small scale, the parts of the same name in the male.

Below the clitoris are two small folds, called the nymphæ. These are connected above, to the preputium clitoridis; they diverge from each other, as they extend below. They vary much in size; in a natural state they may measure about half an inch at the broadest part. They are of a much greater magnitude in the Hottentot female, and have given rise to the reports of travellers, that the sinus pudoris is covered in those persons by a curtain, or apron of skin. About three quarters of an inch below the clitoris, we meet with a round aperture, which is the termination of the female urethra: and just below this is the opening of the vagina; which opening is technically called os externum uteri. This has a very different appearance in a young girl, and in a married woman. In the latter it is a large and free aperture, fully adequate in size to the admission of the penis; in the former it is shut up in a great measure by a thin membrane, called the hymen. This closes the lower portion of the os externum, to various extents in different subjects; and it is torn and destroyed by the consummation of marriage. Some little excrescences, supposed to be the remains of the ruptured hymen, are called carunculæ myrtiformes. The anus is found about one inch behind the commencement of the vagina.

The vagina, or canalis uteri, is a membranous canal, about five inches in length, extending almost directly backwards from the os externum. Its sides are dense and tough; and the surface is covered with nu-

merous wrinkles and prominences, which are less conspicuous in women who have had children, than in virgins.

The uterus is a hollow organ; but its cavity is so small in the impregnated state, and its sides are so thick and dense, that it feels like a solid fleshy mass. Its broadest and largest part, which is called the fundus, is situated directly upwards. The smaller and narrower portion, termed the neck, is downwards. The length of the organ from the fundus to the end of the neck, is about three inches; its breadth at the fundus about one inch, and at the cervix considerably less. It is situated within the cavity included by the bones of the pelvis. The peritoneum passes from the bladder to the anterior surface of the uterus, and completely covers the organ. It is extended from the two sides of the uterus to the bones of the pelvis, forming two broad duplicatures, called the broad ligaments of the uterus; each of which includes three parts, named the appendages of the uterus: *viz.* the ovarium, fallopian tube, and round ligament.

The cavity of the uterus opens into the posterior part of the vagina by an orifice named the os tincæ or os internum uteri.

The round ligament of the uterus is a fibrous chord, passing from the fundus uteri through the abdominal ring, and serving to confine this organ in its proper situation.

The ovarium is an oval fleshy body, situated towards the posterior surface of the broad ligament. It contains some small watery vesicles, called ovula graafiana, which are supposed to be the germs of the future beings, that are to be called into action by the stimulus of the male semen.

The fallopian tube, is a convoluted canal, commencing by a very minute orifice from the corner of the uterus, running along the upper margin of the broad ligaments, and gradually increasing in size, till it ends near the ovarium by a broad trumpet-shaped mouth, open to the cavity of the abdomen, and having an elegant arrangement of plaits and fringes surrounding the aperture, whence it is often called the fimbriated extremity of the tube.

Male organs of generation.—The testes, or glands, which produce the semen, are contained in the scrotum, a bag formed of common integuments, and hanging from the front of the pelvis between the thighs. A prominent line, called the raphe, runs along the middle of this, and divides it into two equal portions. The testes are surrounded and connected in their situation by a loose cellular substance. They are of an oval shape, and about equal in size to a pigeon's egg. They hang from the abdomen by the spermatic chords, which consist of the arteries, veins, lymphatics, and excretory tubes of the testes, united by cellular substance, and covered by a muscle, called the cremaster, by the action of which the testis is occasionally drawn up towards the belly.

The substance of the testis is covered by two membranous tunics, one, which immediately invests it, and is called tunica albuginea; another, which surrounds this more loosely, and forms a bag, in which the testis hangs, the tunica vaginalis.

There is a small body partly distinct from the testis, and placed behind it, called the epididymis.

The substance of the testis is found by a section to be soft: and it is composed of a congeries of very minute tubes, named tubuli seminiferi, which may be unravelled and separated by macerating in water, although they are previously connected into the appearance of a fleshy mass. The diameter of these tubes is estimated at $\frac{1}{200}$th of an inch; and the number of them at about 60,000. If they were joined together, they would form a tube of about 5000 feet long. These tubes terminate ultimately in a single small canal, which, by its innumerable turns and windings, makes up the whole epididymis. If this could be completely drawn out, it would be about 30 feet long. It increases rather in size towards the end of the epididymis, and leaves that body in the form of a simple and unconvoluted tube, assuming the name of vas deferens, and ascending along the back of the spermatic chord to the abdomen. It can be readily distinguished in that situation in the living person: it feels like a hard chord, about the size of a crow quill.

When the spermatic chord has entered the abdomen, the vas deferens leaves it; runs along the back of the bladder, and opens into the commencement of the urethra.

Vesiculæ seminales.—Before the vas deferens terminates in the urethra, it is joined at an acute angle by the canal of the vesicula seminalis.

These vesicles are two soft bodies, lying in contact with the under-surface of the bladder, and formed, each of them, by the convolutions of a single membranous tube. An injected liquor thrown into the vas deferens will pass into the vesicula seminalis, rather than into the urethra; for the open-

ing into that canal is extremely small, while the communication with the vesicula is large and free. Hence it has been supposed that these vesicles are reservoirs for retaining the fluid formed in the testicles until it is wanted.

Prostrate gland.—The origin of the urethra is surrounded by the substance of this gland, which in size and form much resembles a chesnut. Numerous openings are found in the commencement of the urethra, which discharge on pressure a whitish viscid fluid, secreted in the substance of the prostate. A portion of the gland projects into the lower part of the commencement of the urethra, and has received the name of caput gallinaginis: it is on this that the openings of the canals, formed by the junction of the vasa deferentia and vesiculæ seminales are found.

The urethra is subservient to two purposes; the expulsion of the semen in the act of copulation; and the conveyance of the urine from the bladder. Its surface is perfectly smooth, and is covered and protected by a mucous secretion. The diameter of this canal varies slightly at different parts, but may be stated generally at about one-eighth of an inch. At its first departure from the bladder, it is surrounded for one inch by the prostate; it is then continued as a simple membranous tube, but surrounded by muscular fibres for another inch; this is called the membranous portion of the urethra. In the rest of its passage it is surrounded by a vascular substance, called corpus spongiosum; this is accumulated in a considerable mass at its commencement, where indeed the urethra is broader than in any other situation, and this is called the bulb. The seminal and prostatic liquors are poured into the bulb of the urethra, and are forcibly expelled from thence by a sort of convulsive contraction of a muscle, whose fibres surround this part of the canal; the ejaculator seminis. The glans penis is nothing more than a portion of the same vascular mass, which surrounds the rest of the urethra, covered by a very delicate, sensible, and finely organized integument.

The bulb, corpus spongiorum, and glans, are susceptible of the same erection as the body of the penis; which is indeed essential to the performance of their functions, in conveying the fecundating liquor into the body of the female.

The penis consists of two bodies, called crura or corpora cavernosa, which arise separately from the bones of the pelvis; but join so as to form afterwards a single organ. Each crus consists of a very strong and dense ligamentous tube, filled internally with cellular substance, into the cells of which the arteries open, and from which the veins commence. The arteries pour the blood into these organs with great energy, in obedience to the passions of the mind, and thereby distend the ligamentous tubes until they feel perfectly hard and rigid, in which state the whole organ is fitted for the function which it has to perform in the act of copulation. The urethra, surrounded by its spongy substance, runs along the under surface of the corpora cavernosa, and the glans penis is situated at the anterior extremity of these parts.

The body of the penis is covered by common integuments, which being adapted to cover the organ in its extended state, fall into wrinkles when it is collapsed. These are continued beyond the end of the glands, and are inflected, so as to form a hood or covering to the glans, called the prepuce. The latter part is connected to the mouth of the urethra by a small fold named the frenum. The surface of the glans, and the lining of the prepuce are smeared with an unctuous matter of peculiar odour, furnished by some small glands.

OF THE BRAIN AND NERVES.

The brain is a soft and somewhat white substance, situated in the cavity of the skull, and corresponding in form to that cavity. Its parts are supported by a firm membrane, called the dura mater, and its substance is more immediately invested by a delicate membrane, called the pia mater.

The structure of the brain is remarkably constant and uniform; very seldom deviating from the accustomed standard. Varieties of formation occur, not unfrequently, in most other parts of the body; but the parts of the brain preserve an almost invariable relation of form, position, magnitude, and connection; which seems to prove, that the right performance of the functions of this organ requires an exactness in the structure of individual parts.

According to Sœmmerring, the weight of the brain varies from *2lb.* $5\frac{1}{2}$ *oz.* to *3lb.* $3\frac{3}{4}$ *oz.* Of two hundred brains, which this anatomist examined, none weighed four pounds, whereas Haller states its weight as amounting in general to five pounds. The weight of the brain, compared to that of the body, is in an inverse ratio to the age of the sub-

ject. In young fœtuses it is soft and almost fluid: it becomes of a more solid consistence in increasing age, and is firmest in old persons.

The dura mater is a very firm and compact membrane, adhering closely by vessels and fibres to the internal surface of the cranium. It is therefore to be regarded as the periosteum of the internal table of the cranium, as well as a membrane for supporting and investing the brain. It is described by anatomists as consisting of two layers, intimately connected in general, but separated from each other at particular parts, so as to leave vacancies between them called sinuses, into which the veins of the brain pour their blood. The chief of these are, the superior longitudinal, the two lateral, and the torcular herophili. There are besides some smaller ones, as the inferior longitudinal, the cavernous, the circular, the superior, and the anterior petrosal. They all terminate ultimately in the lateral sinus, which, quitting the cranium, takes the name of internal jugular vein.

On the upper part of the dura mater some small eminences are observed, arising from clusters of white granular bodies, situated between this membrane and the pia mater; they are the glandulæ Pacchioni; and fill the pits which may be observed in the skull-cap. The ramifications of the spinous artery, which is the chief nutrient vessel of the dura mater, are very conspicuous on each side of the head. The inner surface of the dura mater is smooth and shining, and has no connection with the pia mater, except where veins pass from the latter membrane to the sinuses.

The processes, which the dura mater forms, for separating and supporting the different parts of the brain, are, 1. the falx cerebri; 2. tentorium cerebelli; 3. falx cerebelli.

The two membranes which immediately invest the brain, were considered as one, and called the pia mater, until a more minute investigation had shewn that it could be divided into two layers. The outer one is called tunica arachnoidea. This is spread over the visible surface of the brain, is of a pale white colour, yet in some degree transparent, very thin, and devoid of evident vessels. It is seen most evidently, where it passes between the two lobes of the cerebellum, and about the middle of the basis cerebri: in other parts, it adheres so intimately to the pia mater, that the distinction can scarcely be demonstrated.

The pia mater every where covers the external surface of the brain, and therefore sends processes into all the convolutions of this organ. It is extremely vascular, and a great portion of the blood, which the brain receives, is spread out upon its surface in minute vessels. The outer surface is tolerably smooth; the inner universally villous, from the torn orifices of innumerable vessels, which entered the substance of the brain.

The surface of the brain appears convoluted, so as to resemble the windings of the small intestines. These convolutions do not in general penetrate more than one inch, or an inch and a half, into the substance.

The contents of the cranium are divided into cerebrum, cerebellum, and medulla oblongata.

The cerebrum is the upper, and by far the largest portion: it occupies all the superior part of the vaulted cavity of the skull, and rests below on the tentorium, the petrous portions of the temporal bones, the sphenoid alæ, and the orbits. Its upper surface presents a regularly convex oval, narrower in front than behind. It is divided into a right and left hemisphere by a deep longitudinal fissure, into which the falx cerebri descends. Each hemisphere is divided into two lobes by means of the fissura magna Sylvii. This fissure commences at the basis of the brain, opposite to the lesser ala of the sphenoid bone; the anterior lobe is that portion of the hemisphere situated in front of the fissure; and the posterior lobe is the division placed behind.

The hemispheres of the cerebrum are united together at about two inches and a half from the surface of the brain by means of a medullary body, called corpus callosum. This is about three inches in length and three quarters of an inch in breadth.

As there are no distinguishable parts in the upper portions of the hemispheres of the cerebrum, it is customary to pare all these away in dissection, nearly to the level of the corpus callosum, in order that we may be able more easily to open, and more particularly to examine, certain cavities, which are situated at the sides of that body, and are called the lateral ventricles.

On making a section of the brain, we perceive that it is composed of two substances; an exterior one, which is of a grey colour, and an interior one, which is white. These are simply termed the cineritious and white substances, or substantia cinerea et alba; or, from the former surrounding the

latter, as the bark does the wood of a tree, they are named, in contradistinction, the cortical and medullary substances of the brain.

The two lateral ventricles are situated in the substance of the brain, by the side of the corpus callosum, (one in either hemisphere). The cavity begins in the front lobe of the brain, as far forwards as the commencement of the corpus callosum; it runs from before backwards in a direction parallel to that body, and at its posterior end bends downwards, and returns obliquely from behind forwards, to terminate almost under its superior extremity. At the place where the ventricle bends, in order to run downwards, there is a particular elongation passing into the posterior lobe, forming a triangular-pointed cavity, and terminating in a cul de sac. This is the digital cavity, or cornu posterius of the lateral ventricle. These and the other ventricles of the brain contain a small quantity of a watery fluid. The disease of hydrocephalus is a morbid increase of quantity in this fluid, which accumulates sometimes to the amount of some pounds, distending and dilating the ventricles enormously. The learned Soemmerring, who may justly be esteemed the first of modern anatomists, places the sensorium commune in this fluid. He has traced all the nerves of the brain to the sides of the ventricles; and concludes, that impressions made on these nerves will be transmitted to the water of the ventricles, which he considers as the organ of the soul.

The two lateral ventricles are separated by a perpendicular partition, called the septum lucidum, which passes from the corpus callosum to the fornix. It contains a small triangular cavity, called the fifth ventricle of the brain.

The fornix is a roundish medullary body, lying between the two ventricles at the lower part. It arises by two anterior crura from the front of the brain; these unite to form the body or pillar of the fornix, which separates behind into two posterior crura, that run into the reflected portion of the ventricles. Under the anterior part of the fornix is a small slit-like opening, by which the two lateral ventricles communicate.

The choroid plexus is a production of the pia mater, containing a vast number of arterial and venous ramifications, floating almost loosely in the cavity of the ventricles. It is first observed in the reflected portion of the ventricle, where it is the broadest and largest: it diminishes in size as it ascends, and terminates just at the opening of communication between the two cavities. The choroid plexuses of the two ventricles are united by a middle expansion passing under the fornix, and called the velum.

The lateral ventricle contains certain eminences, which form its sides; the corpus striatum is the anterior and superior eminence, grey on its external surface, and striated internally. The posterior eminence in each ventricle is called the thalamus nervi optici; it is hemispherical, and white, and joined to its opposite one by an union of substance, called the soft commissure. The hippocampus major is a large elongated eminence lying in the descending portion of the lateral ventricle: and the hippocampus minor is a smaller one in the digital cavity.

The pineal gland, or conarium, is found behind the optic thalami. Its size is about that of a small horse-bean; its colour grey, and figure conical. Two small medullary chords connect it to the optic thalami. In the substance of this body is found a small quantity of a gritty matter, nearly resembling sand. It consists of a number of semi-transparent and light yellow grains. Soemmerring, who first discovered that this belonged to the healthy structure of the brain, calls it the acervulus of the pineal gland. This little body has been more attended to and noticed than it would otherwise have been, in consequence of the chimerical dream of Descartes, who represented it as the seat of the soul.

Below the pineal gland is a square portion of the brain, divided into four superficial eminences, called corpora quadrigemina, and from these a thin production extends to the cerebellum, under the name of valvula cerebri.

By drawing asunder the optic thalami, and separating their soft commissure, we expose the third ventricle of the brain. This appears as an oblong cavity, about an inch and a quarter in length. A round medullary rope is seen in front of it, and a similar one behind; these are called the anterior and posterior commissures. A round aperture is observed under the anterior commissure, beyond which the ventricle terminates by a pointed and conical extremity, from which a short process is continued to the pituitary gland, under the name of infundibulum. The foramen commune anterius is an opening observed between the optic thalami before they are disturbed, and leading from the aperture of communication, which connects the two la-

teral ventricles under the fornix, into the third ventricle. Just before the posterior commissure a round opening is found, leading through a short canal, in front of the tubercula quadrigemina, to the fourth ventricle. It is named canalis medius, iter ad quartum ventriculum, or aquæductus Sylvii. Thus the four first ventricles of the brain have a free communication with each other.

Under the posterior lobes of the cerebrum there is found a transverse production of dura mater, called tentorium, which is attached to the internal transverse ridge of the occiput behind, and to the petrous portions of the temporal bone in front. Under this membrane lie the two lobes of the cerebellum, separated by a small perpendicular production, called the falx cerebelli.

The fourth ventricle is a cavity left between the upper and posterior surface of the medulla oblongata, and the front of the cerebellum. It extends laterally to a considerable distance in the crura cerebelli: a groove runs along the middle of the medulla oblongata, which constitutes the front of the ventricle, and terminates at the end of the cavity in a point. From the lateral productions, and the pointed termination of the cavity, it has been named the calamus scriptorius.

The pituitary gland is a firm substance, differing in texture from the brain, and lodged in the sella turcica. Its name is derived from a supposition that it secreted the mucus of the nose, which in ancient times was supposed to flow from the head. It is connected by the infundibulum to the basis of the brain. Behind the last-mentioned part, at the basis cerebri are seen two small rounded eminences, called corpora subrotunda. The crura cerebri are two large medullary processes going from the cerebrum to the medulla oblongata.

The cerebellum is situated in the lower fossæ of the occipital bone, under the tentorium. It consists of an intermixture of cortical and medullary substance, arranged differently from the order observed in the cerebrum. A perpendicular section of this part discovers a very elegant structure in this respect. A thick trunk of medullary matter sends off processes in every direction; from these other branches proceed, all of which are surrounded by cortex. This is called the arbor vitæ. The arbor vitæ constitutes the crus cerebelli on each side, and these processes join the medulla oblongata.

The medulla oblongata is a large medullary protuberance resting on the basilar process of the occiput. Its connection with the crura cerebri and cerebelli have been already noticed. A medullary cord is continued from its posterior end, under the name of medulla spinalis.

Medulla spinalis. This is a roundish medullary chord, about the size of the fore-finger, arising within the cranium from the medulla oblongata; leaving that cavity at the foramen magnum occipitale, and continued along the canal left in the spine to the upper lumbar vertebræ, where it terminates by forming the cauda equina.

It sends off a pair of nerves at each interval between two vertebræ. It is covered immediately by pia mater and tunica arachnoidea, and more loosely by a sheath of dura mater, which lines the whole spinal canal. It is plentifully supplied with blood vessels. The nerves come off from this body in numerous threads, quite separate from each other at first, but uniting afterwards. The cauda equina consists of the medulla spinalis, entirely resolved into a bundle of such threads.

Structure of the Nerves.—The nerves are soft, white, and fibrous chords, nearly of a cylindrical shape, arising from the brain, or medulla spinalis. When they leave the brain, the pia mater collects the fibres into larger or smaller fasciculi.

The medullary filaments of the nerves are covered by a vascular membrane, called by Reil neurilema, which detaches processes from its inner surface, to surround and invest the smaller divisions and fibres of the medullary substance. By immersing a nerve in alkali, its medulla is dissolved, and the containing membranous tubes, formed of neurilema, are left. Acids dissolve the neurilema, and leave the medullary fibres. These organs receive a considerable supply of blood from vessels ramifying on their neurilema.

By maceration in water, and careful dissection, a nervous trunk may be separated into numerous threads; and each of these, when examined in a microscope, seems to be an assemblage of proportionably smaller fibres. Greater magnifying powers shew those fibres, which before appeared simple, to be composed of still smaller threads: and it is doubtful, whether the ultimate nervous fibre can be discovered. All that is said, therefore, of the form, course, &c. of these ultimate fibres is wholly conjectural. The fibres do not pro-

ceed in a straight uninterrupted course, but join frequently with each other.

A nerve divided in the living subject retracts: the medulla is expressed from its extremities, by the contraction of its membranes, in the form of globules. If the animal be killed at some distance of time from the operation of dividing a nerve, the divided extremities are rather swoln, and are connected by a newly-formed matter. Anatomists have disputed greatly, whether or not this be a real nerve. As this question can hardly be decided by merely anatomical testimony, it appears most philosophical to inquire, whether the new matter will perform the functions of a nerve; and this has been completely proved by the experiments of Dr. Haighton, in the first part of the Philosophical Transactions, for the year 1795.

In some parts of the nervous system, little tubercles, or knots, called ganglia, are found in the course of the nerve, and are usually formed by the concurrence of several branches. These bodies are of various figures, but generally flattened. They partake more of the red colour than the trunks of the nerves on which they are formed, as they possess more numerous blood-vessels. They contain nervous fibres, surrounded by a firm vascular substance.

By the term origin of a nerve, we understand its connection with the brain or spinal marrow. This end is called its sensorial extremity, being considered as the point to which it conveys the impressions made on it by external objects, and from which it receives the commands of the will to be transmitted to the organs which it supplies.

There is considerable difference in form, structure, and consistence, between the individual nerves.

The nerves are arranged in pairs, as they are exactly similar on both sides of the body. Hence any pair of nerves consists of the right and left nerve.

They are sometimes divided into those of the brain, and those of the medulla spinalis; or into the nerves of the organs of sense, the nerves of motion, and the mixed nerves; or, according to the nature of the parts, which they supply, into voluntary and involuntary nerves.

The quantity of nerves distributed to the different structures in the body varies greatly. The organs of sense receive the most copious supply—*viz.* the eye, nose, labyrinth of the ear, ends of the fingers, glans penis et clitoridis, and the rest of the skin. Muscles have also a large share of nerves; the blood-vessels are much more sparingly furnished. The nerves of the viscera are very small in proportion to the size of the organs. Bones, cartilages, tendons, ligaments, membranes, marrow, fat, have no discernible nerves.

Nerves ramify through the body something like arteries: thus, a nervous trunk sends off branches; these, again divided, form ramifications: and in their further progress form twigs, filaments, &c. and this division goes on until the nerve, from its smallness can be no longer traced. Yet we can manifestly discern the nerves in some instances, as in the organs of sense, terminating in a pulpy expansion.

Like the arteries, nerves communicate with each other; and it is conjectured that these communications, like those of the blood-vessels, are designed to obviate the effects of the injury of compression of any particular nervous trunk. In some parts these communications are very numerous, so as to constitute a minute net-work of nervous filaments, called a plexus.

Description of the particular nerves.—There are in the whole body thirty-nine pairs of nerves; of which nine arise from the brain, and thirty from the spinal marrow. There is another pair, called the great sympathetic, which can hardly be ascribed to either of these classes.

Nerves of the brain.

1st pair. Olfactory nerves; arise from the corpora striata, and go through the cribriform lamella of the ethmoid bone to the pituitary membrane of the nose.

2nd pair. Optic nerves; arise from the thalami nervorum opticorum, and proceed to the eye-ball, where they are expanded to form the retinæ.

3rd pair. Nervi motores oculorum; arise from the crura cerebri, and are distributed to some of the muscles of the eye-ball.

4th pair. Nervi trochleares; come from the valve of the brain, and supply the trochlearis muscle of the eye.

5th pair. Nervi trigemini; arise from the side of the medulla oblongata. This nerve divides into three branches, of which the first, or ophthalmic, goes into the orbit, and after giving a few branches there, passes out on the forehead. The second, or superior maxillary, supplies the parts about the upper jaw; a remarkable branch of it is the infra-orbital which comes through the large hole under the orbit to the face. The

third, or inferior maxillary, is distributed to the lower jaw and adjacent parts.

6th pair. Nervi motores externi; from the medulla oblongata to the external straight muscle of the eye.

7th pair. Nervi auditorii. This pair consists of two nerves lying in contact, but completely distinct from each other, both in their origin, course, and distribution. The portio mollis of this nerve is distributed to the labyrinth of the ear. The portio dura goes through the temporal bone, and is very widely spread over the face. These nerves are more correctly termed nervus auditorius, and nervus facialis. The chorda tympani is a branch of communication between the facial nerve and the lingual branch of the inferior maxillary.

8th pair. Par vagum; arises from the medulla spinalis, before it quits the cranium. It receives an accessory branch, that originates from the upper portion of the medulla spinalis, contained in the cervical vertebræ. The par vagum passes along the neck, in company with the carotid artery and the internal jugular vein. It sends off in the upper part of the neck, 1. the glossopharyngeal nerve; 2. superior laryngeal; and 3. the accessory branch. The trunk then enters the chest, and gives rise to the inferior laryngeal or recurrent nerve. It afterwards becomes connected to the œsophagus, and passes the diaphragm in conjunction with that tube, to be distributed finally to the stomach; sending in its passage several branches which supply the lungs.

9th pair. Nervi linguales arise near the former, go through the foramen condyloideum, and supply the muscles of the tongue.

Nerves of the medulla spinalis.—The cervical nerves, soon after they come out from between the vertebræ, communicate with each other. They supply all the muscles which are situated about the vertebræ of the neck. The second sends a large branch which ramifies extensively over the occiput.

The nerve of the diaphragm, called the phrenic or diaphragmatic, arises principally from the fourth cervical nerve. It lies close on the anterior scalenus muscle, then goes over the pericardium to the diaphragm.

The four lower cervical nerves, and the first dorsal, concur in forming the axillary plexus, from which the upper extremity derives its supply. These are large nervous trunks, coming out at the side of the neck, and variously united to each other. They go behind the clavicle with the axillary artery. This plexus sends off the following branches.

1. Nervi thoracici, accompanying the thoracic arteries.

2. Nervus supra-scapularis, distributed with the artery of the same name.

3. Nervus axillaris, following the course of the posterior circumflex artery.

4. Cutaneus internus, running over the brachial artery to the elbow, and then ramifying under the skin of the inner side of the fore-arm.

5. Cutaneus externus, distributed along the outer side of the fore-arm.

6. Median nerve, a large trunk accompanying the brachial artery, then proceeding to the hand, and supplying the thumb, with the two neighbouring fingers, and the radial side of the ring finger.

7. Radial nerve, bends round the os humeri, from the inner to the outer side of the bone; it is distributed superficially to the back of the hand and fingers.

8. Ulnar nerve, accompanying the nerve of the same name to the hand, where it supplies the little finger and the ulnar side of the ring finger.

The twelve pairs of dorsal nerves supply the muscles in their neighbourhood. They give also numerous branches of communication to the great sympathetic.

The five pairs of lumbar nerves send branches to the neighbouring muscles, and give communicating filaments to the great sympathetic. They also produce two nerves distributed to the front of the thigh; *viz.* the anterior crural, which goes out of the pelvis near the external iliac artery, and has an extensive distribution to the thigh and leg; and the obturator nerve, which belongs also to muscles on the front of the thigh.

The sacral nerves give communicating branches to the great sympathetic; and several filaments to the organs of generation in both sexes, to the bladder, rectum, &c. They mostly however unite to form the great sciatic nerve, which is the largest trunk in the body. It goes out of the pelvis at the back part, and passes to the thigh. Here it sometimes is pressed by the weight of the body in sitting, and causes the effect of the foot going to sleep, as it is expressed in common language. This nerve is distributed to the back of the thigh, and over the whole leg and foot.

Great sympathetic or intercostal nerve.—It is first formed by a small filament of the 6th pair, or nervus motor externus, together with another derived from the pte-

rygoid branch of the superior maxillary. In the upper part of the neck this nerve has a very large ganglion lying on the vertebræ, called the superior cervical ganglion. This ganglion receives branches of communication from the five upper pairs of cervical nerves, and sends off a branch to the heart. The trunk descends along the neck, and forms an inferior cervical ganglion, which has communicating filaments from the neighbouring spinal nerves, and sends several branches to the heart, forming the cardiac plexus. The sympathetic nerve then passes through the chest, over the heads of the ribs, receiving branches from each dorsal nerve, and forming a dorsal ganglion between every two vertebræ. In its course it sends off the splanchnic nerves, which go through the diaphragm, and form a vast and most intimate plexus about the root of the cæliac artery, called the cæliac plexus, from which the liver, pancreas, spleen, large and small intestines, and kidneys derive their nerves. All these organs receive several filaments united so as to form plexuses, and surrounding their arterial trunks.

The trunk of the great sympathetic enters the abdomen, and goes over the lumbar vertebræ, receiving branches of communication, and forming lumbar ganglia; it is then continued along the front of the sacrum, where the sacral nerves supply communicating filaments, and where five sacral ganglia are formed.

ORGANS OF SENSE.

Organ of vision.—The globe of the eye is contained in a bony socket, formed by the bones of the cranium and of the face. It is furnished with muscles which can move it in every direction, and surrounded by a very soft and delicate kind of fat, which yields to it in all its motions. It is composed of certain membranes, called its tunics or coats, and of other parts termed humours.

Its figure is very nearly spherical; but the transparent portion in front is the section of a smaller sphere than the globe. The optic nerve, to which the eye-ball is attached posteriorly, enters considerably on the inside of the axis of the eye.

The coats of the eye are disposed concentrically; and the exterior, which is very dense, firm, and tough, is called the sclerotica. This does not cover the whole globe, but leaves a circular opening in front, filled by the transparent cornea, which, although pellucid, is a very firm and strong membrane. Hence the sclerotica and cornea together form a very complete exterior case, which defends and supports the more delicate parts within. The necessity of having the front of the globe transparent, for the purpose of admitting the rays of light, is obvious.

Under the sclerotica a soft and vascular membrane surrounds the eye-ball, and is called the choroid coat. It is connected to the sclerotica by a loose adhesion, which can be destroyed by blowing air between the membranes; but in front this adhesion is stronger, and forms a white circle, named orbiculus or ligamentum ciliare. The colour of the choroid coat is a deep brown, approaching to a black, and this colour is derived from a substance called pigmentum nigrum, which separates from the choroid by maceration, and dissolves in water so as to render it turbid.

The inner surface of the choroid coat, which is universally coloured by pigmentum nigrum in the human subject, is sometimes called tunica ruyschiana; as Ruysch endeavoured to prove that it formed a distinct membrane from the external part. It is this inner surface that possesses the brilliant colours observable in animals, whence the appellation of tapetum. This surface lies in contact with the retina, but does not adhere to that membrane. On the front of the eye however, and beyond the anterior margin of the retina, the choroid is closely attached by means of numerous and very delicate folds, called the ciliary processes, to the surface of the vitreus humour, round the margin of the crystalline lens.

The iris is a membrane continued transversely across the eye-ball, behind the cornea, and appearing as a continuation of the choroid from the orbiculus ciliaris. The round opening in the front of this membrane is called the pupil: it allows the passage of the rays of light into the interior of the eye. This aperture varies in its dimensions, according to the quantity of light to which the organ is exposed: a strong light causes the pupil to become contracted, in order to exclude a portion of the rays of light, which offend the organ. The aperture is dilated in a weak light, to let in as many rays as possible. Some anatomists have thought proper to employ themselves in debating at length whether these motions arise from a really muscular structure or no; but we believe that they have not yet settled the point completely.

The name of iris was applied to this part, from the diversity of colours observable in

it in different individuals; and it is the colour of this that produces the colour of the eye, in the popular sense of the phrase. There is a remarkable correspondence in this point between the skin and hair and the iris. A light complexion and hair is accompanied with blue, grey, or the lighter colours of the iris; while a dark skin and black hair are attended with the dark brown iris.

In that curious variety of the human race, called the Albinos, where the skin and hair are of a dead milk-white hue, in consequence of a total absence of the rete mucosum or colouring principle, the colouring matter of the iris and choroid is also deficient, and these parts appear red from the numerous blood-vessels which they contain.

The posterior surface of the iris is covered by pigmentum nigrum, and is called the uvea.

Under the choroid coat is found a third membrane of the eye-balls, called the retina, which is formed by the expansion of the medullary substance of the optic nerve, and forms the immediate organ of vision. It is of a yellowish grey colour, and so extremely soft as almost to be lacerated by the slightest touch. Its outer surface is entirely unconnected with the choroid coat; and the inner surface is expanded on the vitreous humour, but not connected to it. It terminates in front by a distinctly defined edge, where the ciliary processes begin to adhere to the vitreous humour. On the inside of the retina are seen the branches of an artery and vein, which enter through the centre of the optic nerve, (arteria et vena centralis oculi). The part at which it enters the eye is termed the porus opticus, and is of course insensible; and hence physiologists have explained the reason why the optic nerve is inserted out of the axis of the eye; as otherwise the axis of vision would have fallen on an insensible part of the retina.

On the outer, or temporal side of the retina, there is a fold of the membrane of a bright yellow colour, in the recent state, and there is also said to be an aperture. These circumstances were first pointed out by Soemmerring, and have been named after him.

The vitreous humour occupies the greatest share of the globe of the eye. It consists of a clear water contained in a cellular substance, which is so perfectly transparent as to resemble pure glass, whence its name is derived. The cellular substance is condensed on the surface into a smooth membrane, called the membrana hyaloidea. This is marked in front by a circular series of black radiated lines, caused by the adhesion of the ciliary processes, which, like other parts of the choroid, are covered with pigmentum nigrum. Under these a circular canal runs, named the canal of Petit.

The crystalline humour or lens is imbedded in the front of the vitreous humour. Its size is about that of a pea, but it is much more flattened in form. It is of a waxy consistence, softer externally, and growing gradually firmer towards the centre. The lens is contained in a capsule, formed by the membrana hyaloidea, splitting into two layers. It has no apparent connection to this capsule. It is an opaque state of this body that constitutes the disease called cataract.

The aqueous humour is a small quantity of transparent water, placed immediately behind the cornea, and occupying the space between that membrane and the crystalline lens: it is easily reproduced when let out.

In the midst of the space occupied by this humour the iris is found, and it divides the space into two portions, called the anterior and posterior chambers of the eye; which communicate by means of the pupil. The anterior is much the largest of these.

The choroid coat, ciliary processes, and iris are very vascular, and derive their supply from the ciliary branches of the ophthalmic artery.

The iris is very largely supplied with nerves from a small ganglion, named lenticular, formed on a branch of the nervus motor, or nerve of the third pair. These are called the ciliary nerves.

Of the eye-lids and lacrymal apparatus.—The eye-ball is covered by two moveable curtains, formed by a folding of the common integument, and called the eye-lids. In order to keep these uniformly expanded, and to prevent them from forming wrinkles, each of them contains a thin portion of cartilage, adapted in figure to the convexity of the globe, and called the tarsus. In order to provide still further for the greatest possible facility of motion, the eye-lids are lined by a smooth and polished membrane, and the globe of the eye is covered by the same membrane, on its anterior part: this is called conjunctiva, as it serves to connect the front of the eye-ball to the eyelids.

The junctions of the eye-lids are called the

internal and external canthus, or angle of the eye.

They are opened by the levator palpebræ lifting up the upper lid; and this muscle is in a state of constant action so long as we keep our eyes open. They are closed by the circular orbicularis palpebrarum.

The cilia, or eye-lashes, are two rows of strong curved hairs implanted in the opposed edges of the two eye-lids, and admirably calculated for protecting the eye from dust or other foreign bodies.

The hairy prominences above the eye-lids are the supercilia, or eye-brows; these are very moveable; they serve as a protection to the eyes, and are much concerned in expressing the passions.

In order to facilitate the motions of the eye-lids and eye-balls on each other, the surface of the conjunctiva is constantly moistened by a watery and mucilaginous fluid poured out by the arteries of the part. The incrustations of the mucilage in the night would glue the eye-lids together; but this effect is obviated by a natural ointment formed in a very elegant glandular apparatus on the inner surface of the tarsi. We there find about 16 or 17 longitudinal parallel rows of very minute glandular bodies; and these pour out their sebaceous secretion from a series of apertures on the edges of the eye-lids. They are called the meibomian glands, and ciliary ducts.

The fluid just described is constantly formed on the surface of the conjunctiva; but on extraordinary occasions, as when an irritating foreign body is in the eye, or in consequence of affections of the mind, a fluid is poured out in greater abundance, which has the name of tears, and is secreted by the lacrymal gland. This is a small conglomerate gland, situated in the orbit, near the upper eye-lid, and having ducts which terminate on the surface of the conjunctiva; but which, on account of their minuteness, are hardly demonstrable in the human subject. The utility of this secretion in washing away any foreign substance must be sufficiently obvious.

The superfluous part of the lacrymal secretion is conveyed through two very fine tubes to a small bag, situated at the internal angle of the eye. These tubes commence by open mouths, called the puncta lacrymalia, from the inner extremities of the eye-lids, and are about equal in size to admit a hog's bristle.

There is a little fleshy projection at the corner of the eye, and between the two puncta, called caruncula lacrymalis.

The lacrymal sac is a small membranous bag, placed in the hollow formed at the inner edge of the orbit. The tendon of the orbicularis palpebrarum, which generally forms a slight eminence visible through the skin, crosses the middle of this bag.

A canal, called the ductus nasalis, and lodged in a groove of the superior maxillary bone, conveys the tears into the nose, where it terminates by an open orifice within the inferior turbinated bone.

ORGAN OF HEARING.

This organ is divided into two parts, the external and internal ear, by the membrana tympani. The situation of the former on the outside of the head is well known; the latter is contained in the petrous portion of the temporal bone.

The external ear consists of two parts, *viz.* the pinna, or ear popularly so called, and a tube called meatus auditorius externus, leading from the pinna to the membrana tympani. These parts serve for collecting sounds, and conveying them to the membrana tympani.

The pinna consists of a convoluted cartilage inclosed by common integuments. The lower part, which is pierced for ear-rings, has no cartilage, and is called the lobulus. The helix is the fold forming the external circumference of the ear; the next eminence to this, which forms the margin of the great cavity of the external ear, is called anthelix; it separates at its upper and anterior end into two processes, named crura. The projection immediately in front of the meatus is the tragus, and that immediately opposite, the antitragus. The great cavity within the anthelix, and leading to the meatus, is called the concha. Several sebaceous glands are situated in the folds of the ear.

The meatus externus is formed first by a portion of cartilage, continued from the pinna, and more interiorly it consists of a canal in the substance of the bone. This bony part does not exist in the fœtus, where the meatus is wholly cartilaginous. The common integuments continued from the pinna line the meatus externus, and the cuticle is produced over the membrana tympani.

The surface of the meatus at its commencement is furnished with numerous fine hairs, and the canal is moistened by a secretion of an oily and inflammable nature, called cerumen. This is produced by numerous small glands, visible on the external surface of the meatus, and distinguishable by their yellowish colour. The cerumen concretes, and is collected sometimes in such

quantity, as to induce a slight degree of deafness, which is easily removed by syringing with warm water.

The membrana tympani, which is a circular membrane above a quarter of an inch in diameter, is stretched across the inner extremity of the meatus, and derives its name from a comparison with a drum head, to which it bears some analogy in its use. In the fœtus it is stretched on a distinct bony ring, called the annulus auditorius. This ring is deficient at its upper part, and has no bony union to the rest of the temporal bone, but it becomes united soon after birth.

This membrane is concave on its exterior surface, and convex towards the tympanum. Its position is inclined, the upper margin being more towards the outside of the head, and the under part farther inwards; so that the superior part of the meatus forms an obtuse angle, and the inferior part an acute angle with the membrane.

The internal ear consists of two divisions, viz. the tympanum and the labyrinth.

The tympanum is an irregular bony cavity, which will about admit the end of a finger, hollowed out of the temporal bone, just within the membrana tympani. It has several communications with the neighbouring parts.

Opposite to the membrana tympani are two openings, which lead to the labyrinth of the ear. The upper one is named the fenestra ovalis, the lower one the fenestra rotunda, and the projection between them is called the promontory. The fenestra ovalis is filled, as we shall presently see, by one of the little bones of the tympanum, and the fenestra rotunda is closed by a membrane.

The eustachian tube, or iter a palato ad aurem, opens in front of the tympanum. It commences by an expanded cartilaginous orifice at the back of the nostrils, passes through the substance of the temporal bone, and terminates by a contracted orifice in the tympanum. Its office is to convey air into the cavity of the tympanum. The membrana tympani is thrown into vibrations by the impulse of the sonorous undulations of the air, and that vibration could not take place unless there was air in the inside as well as on the outside of the membrane. Water, or any other fluid, would not have answered the purpose. Hence an obstruction of this tube causes deafness, which surgeons have attempted to remedy by puncturing the membrana tympani. An opening in the latter membrane of a small extent does by no means injure hearing; for many persons have the power of impelling tobacco smoke, or agitating the flame of a candle through the ear, and yet seem to have a perfect use of the organ. In these cases the air or smoke enters the eustachian tube from the throat, and passes through the unnatural aperture in the membrane.

The mastoid process of the temporal bone is composed internally of numerous cells, communicating with each other, and finally opening into the back part of the tympanum. These do not exist in the fœtus.

The cavity of the tympanum contains a chain of small bones, called ossicula auditus, connected by one end to the membrana tympani, and by the other to the fenestra ovalis. Of these the first, which is compared to a hammer, is called the malleus; the second is named the incus, and the third the stapes.

The malleus possesses a manubrium, or handle, a long and short process, and a head which forms an articular surface.

The incus resembles a grinding tooth, with its two fangs diverging. We remark in it a body, the surface of which is hollowed out to receive the head of the malleus; a long and a short leg.

The stapes has an exact resemblance to the iron part of a stirrup; it has a head, two crura, and a basis.

The handle of the malleus is firmly connected to the membrana tympani; and hence arises the external concavity and internal convexity of the membrane. The head of that bone is joined to the body of the incus, whose long leg is articulated to the head of the stapes. The basis of the stapes fills up the fenestra ovalis. The ends of the bones forming these articulations are covered with cartilage, and furnished with capsules like other joints.

The bones of the tympanum have some small muscles connected to them, by which they are moved outwards, or towards the membrana tympani, and inwards, or towards the fenestra ovalis. The first of these motions relaxes, the latter stretches the membrane. The names of these muscles are, tensor tympani, laxator tympani, and stapedeus.

The nerve called chorda tympani passes across the tympanum, between the handle of the malleus and the long leg of the incus.

The use of the ossicula auditus seems to be that of transmitting the vibrations of the air from the membrana tympani to the

labyrinth. The final use of the muscles which moves these bones is unknown.

The labyrinth of the ear consists of three parts:—1. A spiral bony canal, twisted like a snail-shell, and thence called the cochlea. 2. Three semicircular bony canals: and 3. A small cavity, called the vestibulum, into which the cochlea and the semicircular canals open. These parts are formed of the hardest bone in the body, almost equal in solidity to ivory, and the petrous portion of the temporal bone, which incloses them, is of a similar structure. In the fœtus the labyrinth is surrounded by a softer and looser kind of bone, so that it can be most easily dissected at that age.

The vestibulum is about equal in size to a large pea, and the fenestra ovalis opens into the middle of the cavity. It has also five openings from the semicircular canals; the superior and exterior joining by one of their extremities, and opening by a common hole.

The cochlea has two turns and a half. Its canal turns round a bony centre, called the modiolus, to which is attached a thin plate of bone, projecting into the cavity of the cochlea, and named lamina spiralis. — This projecting plate divides the canal of the cochlea into two parts; one opening into the vestibulum, the other at the fenestra rotunda. The latter is called the scala tympani, the former scala vestibuli.

The vestibulum, cochlea, and semicircular canals are lined by a delicate vascular membrane, on which the portio mollis of the seventh pair of nerves is distributed. This membrane contains a clear water.

The filaments of the auditory nerve pass from the meatus auditorius internus through a number of very small apertures, which lead to the labyrinth, and they terminate on the vascular membrane of the labyrinth, so that the nervous pulp is exposed almost bare to the contained fluid. The distribution of the nerve on the cochlea is particularly beautiful. The aqueducts of the ear are two very fine tubes passing from the vestibulum and cochlea to open on the surface of the dura mater.

ORGAN OF SMELLING.

The nose is a cavity of very irregular figure, formed chiefly by the bones of the face, and communicating with the various sinuses or bony cells formed in the head.

It is separated from the brain above by the cribriform lamella of the ethmoid bone. This separation is a perfect one, and the two cavities of the cranium and nose are wholly distinct from each other, although they are supposed by the uninformed in anatomy to communicate together.

The bottom of the cavity is formed by the upper surface of the palate.

The general cavity is divided into two equal halves, called nostrils, by the septum narium, a thin and flat bony partition descending from the cribriform lamella to the palate. The flat surface of the septum may therefore be said to form the inner side of the nostril; and its outer side presents three bony eminences, called the conchæ narium, or turbinated bones.

Moreover, the following excavations or sinuses open into the cavity at various parts. Two frontal sinuses; numerous cells of the ethmoid bone; two sphenoidal sinuses; and two great hollows in the upper jaw bone, called the antra, or maxillary sinuses.

The front openings of the nostrils are well known. This aperture is heart-shaped in the skeleton, the broadest part being towards the mouth; but it is much altered in the recent subject by the apposition of pieces of cartilage, the broadest of which are the lateral portions termed alæ nasi. Behind, the nostrils open by large apertures into the upper and anterior part of the pharynx, above the velum pendulum palati.

The sides of the bony cavity just described are covered by a thick, soft, and very vascular membrane, called membrana schneideriana, or pituitaria. Its surface is constantly moistened by a secretion of mucus from the arteries, with which it is very copiously supplied. This prevents the effects which the current of air in respiration would otherwise produce, of drying the membrane. It is only an increased quantity of this secretion, altered too somewhat in its quality, that is discharged from the nose in colds, and which is popularly supposed to come from the brain. This membrane extends into the cells which communicate with the nose, but is thinner and less vascular there.

The ethmoidal cells open into the cavity of the nose, partly above, and partly under the loose edge of the superior turbinated bone. The frontal sinuses open into the front of these cells; and the sphenoidal sinuses into the back part of them. The antrum maxillare has a round opening between the two turbinated bones. The nasal duct opens under the inferior of these bones: and the expanded orifice of the eustachian

tube is just at the communication between the back of the nose and the pharynx.

The filaments of the olfactory nerves, having penetrated the cribriform lamella, are distributed to the pituitary membrane that covers the septum nasi and superior turbinated bone.

Several small branches from the fifth pair are also distributed on the nose, at different parts.

ORGAN OF TASTE.

It would be a waste of words to describe the situation and form of the tongue. This organ presents a most interesting subject to the physiologist, from the concern which it has in the functions of mastication, deglutition, and articulation, besides that it constitutes the organ of the sense of taste.

Its bulk is made up of numerous muscles, which are distinct at their origin, but become mixed and confused at their insertion into the tongue. The union of these fibres with each other, and with the fatty substance which connects them, constitutes the peculiar substance of the tongue. It is covered externally by a continuation of the common membrane of the mouth. This membrane, however, on the edges, tip, and upper surface of the organ, is covered with small projecting processes, called papillæ, in which the sense of taste resides.

Towards the back of the tongue several mucous glands are found, with openings that would admit a bristle. These secrete a fluid to facilitate the passage of the food through the isthmus faucium.

Next to these openings, and still at the posterior part of the organ, are found eight or ten large papillæ, arranged in the form of the letter V, with the pointed part towards the throat. These are the papillæ magnæ, or capitatæ. They consist of a round body, surrounded by a circular fold of membrane. These also are mucous glands.

The most numerous class of papillæ are those which occupy the sides and tip of the tongue. These are the smallest in size, so as to have been compared to the villi of the skin; and conical in shape. They are called papillæ conicæ or villosæ. Among these a few larger ones are scattered, the papillæ semilenticulares.

The tongue receives three large nerves on each side; 1st, the glossopharyngeal branch of the eighth pair, distributed to the back of the tongue, and upper part of the pharynx: 2ndly, the lingual nerve, or nerve of the 9th pair, which supplies the muscles: and 3rdly, the lingual branch of the inferior maxillary, which goes to the papillæ chiefly.

ORGAN OF THE SENSE OF TOUCH.

This sense may be considered, in the most enlarged acceptation of the term, as residing in the surface of the body in general: in a more limited view, we regard the ends of the fingers as more particularly adapted, by their organization, for exploring the tangible properties of bodies.

The skin or exterior covering of the body, is divided into three layers; *viz.* the cuticle, the rete mucosum, and the cutis. These parts are called the common integuments of the body. To them a fourth is sometimes added, *viz.* the adipous membrane. But although there is generally a layer of fat under the skin, this is not invariably the case.

The cutis vera, or true skin, is a very dense and compact membrane, formed, as it were, by a general condensation of the cellular substance on the surface of the body. It is this that forms leather, when subjected to the operation of tanning. Its thickness varies in different parts of the body. It possesses considerable elasticity, by virtue of which it yields to any distending power, and on the cessation of such force recovers its former state. It has also a species of contractility, which is evinced by its corrugation from cold. Its colour in the inhabitants of all countries is white. It possesses great vascularity, and has also an abundant supply of nerves, which bestow on it acute sensibility. It is thrown into folds in different parts of the body, in consequence of their motions on each other; this may be particularly observed in the hands and fingers. Its surface is also marked by lines, crossing and intersecting each other variously, and intercepting spaces of all shapes and descriptions.

Such parts of the cutis as are the most highly organised, have numerous fine hair-like processes, called villi. These are more vascular than other parts, and receive also a more copious supply of nerves. Such parts enjoy a higher and more acute sensibility. This is the case with the ends of the fingers, which, both by their form and organisation, are more especially fitted to act as organs of touch. It is also observed in the lips, and in the glans penis.

The rete mucosum is a soft mucous substance, readily demonstrable in the negro, where it is thick and of a black colour, but

hardly discernible in the European. This is the seat of the colouring matter of the skin.

The cuticle is a thin semitransparent covering, possessing no particular arrangement of parts, no vessels nor nerves. It adheres, however, closely to the subjacent parts, and is exactly moulded to the surface of the cutis. It is best seen after the action of a blister, when it is elevated by an effusion of fluid under it. In the dead body it may be separated from the cutis by putrefaction, or by immersion in hot water. In this way it may be removed, entire, from the hand and fingers, so as to resemble a glove.

It forms an insensible medium, interposed between the nerves of the organ of touch and external objects: and as it covers the whole exterior of the body, our surface is actually dead. When removed from any part, it is speedily renewed by the cutis. Its thickness varies in different parts; being greatest where it is exposed to friction, as in the palms and soles. Its thickness is here also increased by friction, as we may observe by contrasting the hand of a labourer with that of a person who does not use his hands in the same rough manner.

It appears that the cuticle is impervious to fluids, as the serum contained in a blistered part does not transude; neither does a dead body become dried while covered by this expansion; but, when that is removed, it is speedily reduced by evaporation to a state of dryness. Yet it must be penetrated by the vessels in a living body, as is proved by the immense discharge both of sensible and insensible perspiration. Probably, also, the absorbents open on it by patulous orifices; for mercurial ointment, rubbed on the skin, affects the system.

Sebacious glands are formed under the skin, in a few situations only, as about the nose and external ear.

Hairs consist of an insensible excrescence produced from the cutis. Each hair grows from a small bulb, and is lengthened by means of additions made to it in the bulb. These bodies perforate the cuticle.

Nails are portions of a horny substance, connected to the ends of the toes and fingers. Their surface corresponding to the back of the finger is convex, and tolerably smooth: the opposite part is laminated and concave. These laminæ adhere to corresponding ones of the cutis. The integuments advance for some length over the root of the nail, so as to cover a considerable portion of it; and the cuticle adheres closely to its surface. The nail grows like the hair, by additions from below.

The account of the progress of the embryo after conception, or the description of the gravid uterus and its contents, together with the enumeration of those circumstances of anatomical structure, which are peculiar to the fœtus, will be given under the article Fœtus.

EXPLANATION OF THE ANATOMICAL PLATES.

Plate I.

Fig. 1. *A front view of the skeleton.*

1. The cranium.
2. Os frontis.
3. 3. The orbits.
4. Upper jaw-bone.
5. Teeth.
6. Lower jaw-bone.
7. The seven true ribs.
8. The five false ribs.
9. First bone of the sternum.
10. Second bone of the sternum.
11. Ensiform cartilage.
12. The five lumbar vertebræ.
13. Ilium, or haunch-bone.
14. Os ischii.
15. Os pubis.
16. Os sacrum, or bone of the rump.
17. Symphisis pubis.
18. Thigh-bone.
19. Head of the thigh-bone.
20. Trochanter major.
21. Patella, or knee-pan.

22, 23. External and internal condyles of the thigh.

24. Tibia.
25. Fibula.
26. Bones of the tarsus.
27. Bones of the metatarsus.
28. Bones of the toes.

a. The clavicle, or collar-bone.
b. Scapula, or shoulder-blade.
c. Humerus, or bone of the arm.
d. Ulna.
e. Radius.
f. First row or phalanx of carpal bones.
g. Second row or phalanx of carpal bones
h. Bones of the metacarpus.
i. First phalanges of the fingers.
k. Second phalanges of the fingers.
l. Third phalanges.
m. Three phalanges of the thumb.

Fig. 2. *View of the right ventricle and pulmonary artery laid open.*

These parts are marked A *a* in Plate VI. Fig. 1.

a. A triangular flap of the fleshy side of the ventricle turned back to expose the cavity.

b. Columnæ carneæ of the heart.

c. Tricuspidal valve.

d. The three semilunar valves in the mouth of the pulmonary artery, which is slit open.

e. *e*. Cut edges of the ventricle.

Fig. 3. *View of the cavity of the left ventricle and mouth of the aorta.*

a. *a*. Cut edges of the ventricle.

b. Columnæ carneæ.

c. Chordæ tendineæ.

d. Mitral valve.

e. Semilunar valves of the aorta.

PLATE II.

Fig. 1. *Back view of the skeleton.*

1, 2. Ossa parietalia.
3. Os occipitis.
4. Os temporis.
5. Mastoid process of the temporal bone.
6. The seven cervical vertebræ.
7. The twelve dorsal vertebræ.
8. The five lumbar vertebræ.
11. Os sacrum, or rump-bone.
12. Os coccygis, or crupper bone.
13. Ilium.
9. Ischium.
14. Neck of the thigh-bone.
15. Trochanter major.
16. Trochanter minor.
17. Condyles of the thigh.
18. Malleolus externus.
19. Malleolus internus.
20. Os calcis.

Fig. 2. *The small bones contained in the tympanum of the ear.*

1. Malleus.
2. Incus.
3. Os orbiculare.
4. Stapes.

Fig. 3. *A view of the same bones as joined to each other, and as connected to the membrana tympani.*

e. Membrana tympani with the handle of the malleus connected.

f. Head of the malleus joined to

g, which is the body of the incus.

h. Base of the stapes.

Fig. 4. *A view of the labyrinth of the ear.*

a. Three semicircular canals unopened.

b. Section of the cochlea,

c. Auditory nerve.

d. Branches of the nerve going to the vestibulum and semicircular canals.

e. Trunk of the nerve most beautifully ramified on the solid axis, and projecting bony plate of the cochlea.

Fig. 5. *Second view of the labyrinth; representing the vestibulum and semicircular canals laid open, and the branches of the auditory nerve terminating on those parts.*

a. Cavity of the vestibulum.

PLATE III.

Fig. 1. *A front view of the muscles.*

The right side of the figure represents the first or most superficial stratum: on the left side the second layer is exhibited. It would be impossible to refer to all the muscles exhibited in this and the following muscular plates; we must therefore confine ourselves to the more obvious and important ones.

a. Orbicularis palpebrarum.

b. Orbicularis oris.

c. Zygomatici.

d. Sterno-cleidomastoideus.

1. Platysma myoides.

2. Pectoralis major.

e. Latissimus dorsi.

3. Obliquus externus abdominis.

4. Rectus abdominis.

+. Pectoralis minor.

f. Serratus anticus.

g. Obliquus internus abdominis.

5. Deltoid muscle.

6. Biceps flexor cubiti.

h. Supinator radii longus.

i. Pronator radii teres.

k. Flexor carpi radialis.

l. Extensors of the thumb.

m, *n*. Two heads of the biceps flexor cubiti.

o. Opponens pollicis.

p. Muscles of the little finger.

q. Flexor tendons of the fingers.

r. Flexor digitorum profundus.

s. Flexor longus pollicis.

7. Tensor vaginæ femoris.

8. Sartorius.

9. Vastus externus.

10. Rectus extensor femoris.

11. Vastus internus.

12. Tibialis anticus.

13. Extensor muscles of the toes.

14. Extensor tendons of the toes.

Fig. 2. *Posterior surface of the eyelids, with the lacrymal gland.*

a, *b*. Posterior surface of the eyelids,

The perpendicular parallel lines are formed by rows of the sebaceous or meibomian glands.

c. c. c. c. Cut edge of the tunica conjunctiva, where that membrane was reflected from the eyelids to the eyeball.

d. Lacymal gland.

e. Openings of its ducts on the surface of the conjunctiva.

f. Puncta lacrymalia.

g. Caruncula lacrymalis.

Fig. 3. *Front view of the eyebrow and eyelids: designed to shew the margins of the latter, and their union with each other.*

b. Fold of the skin between the upper eyelid and the eyebrow.

c. Orifices in which the hairs of the eyelash were implanted.

f. Openings of the ducts of the sebaceous glands along the margin of the eyelid.

d. m. Superior and inferior punctum lacrymale, or external openings of the canals, by which the tears are conveyed to the lacrymal bag.

h. Caruncula lacrymalis.

g. External canthus or angle of the eye, the opposite part is the internal canthus.

Fig. 4. *View of the lacrymal passages.*

a. a. Puncta lacrymalia.

b. b. Lacrymal ducts, commencing from the puncta, and terminating in

c. The lacrymal bag.

d. Nasal duct.

e. Its termination at the nose.

f. Lacrymal gland.

PLATE IV.

Fig. 1. *A posterior view of the muscles; in which the right side exhibits the superficial, and the left a deeper-seated stratum.*

a. Temporal muscle.
b. Supraspinatus.
c. Infraspinatus.
d. Teres minor.
e. Teres major.
f. Pyriformis.
g. Vastus externus.
h. Biceps flexor cruris.
i. Semitendinosus.
k. Peronei muscles, &c.
l. Their tendons.
m. Levator scapulæ.
1. Trapezius.
2. Rhomboideus.
3. Latissimus dorsi.
4. Splenius capitis.
5. Complexus.
6. Serratus inferior posticus.
7. 7. Sacrolumbalis and longissimus dorsi.
8. Deltoid.
9. 9. Triceps extensor cubiti.
11. Gluteus maximus
12. Gluteus medius.
13. Flexors of the knee-joint.
14. Gastro-cnemius.
15. Soleus.
16. Tendo achillis.

Fig. 2. *A view of the surface of the brain, exposed by removing the skull-cap.*

On the right side the brain is covered by its dura mater: that membrane is cut through, and turned aside so as to expose the left hemisphere.

Fig. 3. *The skull and brain cut through horizontally in about the middle.*

It shews the difference of the cortical and medullary substances, and the union of the two hemispheres by the corpus callosum.

d. The dura mater, which covered the brain, and formed the falx thrown back.

e. e. Cineritious substance.

g. Medullary substance.

h. Corpus callosum.

Fig. 4. *The basis of the brain, with the origins of the nerves.*

a. a. Anterior lobes of the brain.
b. b. Middle lobes.
c. c. Posterior lobes.
d. d. Two lobes of the cerebellum.
f. Pons varolii, or medulla oblongata.
e. Medulla spinalis.

PLATE V.

Fig. 1. *Superficial view of the contents of the abdomen.*

d. d. Omentum.

c. c. Liver.

f. f. f. f. Various convolutions of small intestine.

a. a. a. Transverse arch of the colon covered by the omentum.

Fig. 2, *is a scheme to represent the whole tract of the intestinal canal; as the stomach and some other parts do not come into view in the preceding figure. The arrows represent the course of the aliment.*

a. End of the œsophagus.

B. The stomach.

h. Pylorus.

g. i. k. l. Various convolutions of small intestine.

e. Caput coli.

m. Appendix vermiformis.

f. Ascending colon.

a. a. a. Transverse arch of the colon.

b. Sigmoid flexure of the colon.

c. Rectum.

PLATE VI.

Fig. 1. *A view of the heart and lungs, with the adjacent large blood-vessels of the thorax and abdomen.*

A. Right ventricle of the heart.

e. Right auricle.

1. 2. 3. The three lobes of the right lung.

4. 5. Two lobes of the left lung.

a. Origin of the pulmonary artery.

b. Arch of the aorta.

x. Arteria innominata.

y. y. Right and left carotid arteries.

u. u. Jugular veins.

E. E. Left subclavian vein.

c. Superior vena cava.

k. Descending aorta, sending off different branches to the abdominal viscera; as, *l.* the cæliac; *m.* superior mesenteric; *n.* inferior mesenteric; *o. p.* renal arteries.

h. Trunk of the inferior vena cava.

r. q. Renal veins.

v. Trunk of the absorbing system, called the thoracic duct.

d. Termination of that duct in the angle formed by the junction of the left subclavian and jugular veins.

Fig. 2. *A view of the thorax and abdomen, representing some parts not seen in Plate V. and now exposed by lifting up the liver.*

1. Thyroid gland.

2. Trachea. The large blood-vessels correspond to those of the preceding figure.

3. The heart.

4. Left lung.

5. Right lung.

6. Under surface of the left lobe of the liver.

7. Under surface of the right lobe.

8. The stomach.

9. Great omentum.

10. Small intestines.

11. 11. The coverings of the abdomen cut through and turned aside.

12. Bladder of urine.

13. Lesser omentum.

14. Gall-bladder.

Fig. 2. *Gall-bladder and biliary ducts, and pancreas.*

K. Hepatic duct formed by various branches coming from the liver.

L. Cystic duct.

I. Gall-bladder.

N. Ductus communis.

P. Pancreas with its duct.

Q. A portion of the intestines, with a longitudinal slit, the opening of the united ducts.

ANAXAGORAS, in biography, a celebrated philosopher among the ancients. He was born in Ionia about the 70th Olympiad, became the disciple of Anaximenes, and was afterwards a lecturer himself at Athens. In this city he was cruelly persecuted, and at length banished. He went to Lampsacus, where he was greatly honoured during his life, and still more respected after his death. Statues have been erected to his memory.

Anaxagoras was a mathematician, and wrote, during his imprisonment at Athens, upon the quadrature of the circle. As a philosopher, he introduced some important innovations, as they were then called, but which redound much to his honour: he maintained, in opposition to the common systems of a plurality of Gods, that an infinite mind is the author of all motion and life. Plato asserts, that Anaxagoras taught that "mind was the cause of the world, and of all order," and that "while all things else are compounded, this alone is pure and unmixed:" he ascribes to this principle two powers, *viz.* to know and to move. Testimonies to this purpose in favour of Anaxagoras are numerous; Plutarch speaking of the Ionian philosophers who flourished before this great man, says, that they made fortune, or blind necessity, the first principle in nature; but Anaxagoras affirmed, that a pure mind governs the universe. By Diogenes Laertius he is represented as the first person "who superadded mind to matter." He died in the year 428 before Christ, and throughout his life he supported the character of a true philosopher. Superior to the motives of avarice and ambition, he resigned in early life a patrimony that would have secured him distinction and independence, in order that he might give himself up wholly to the pursuits of science, and in the midst of the vicissitudes of fortune preserved an equal mind. Being asked, just before his death, whether he wished to be carried for interment to his native city, he replied, "it is unnecessary; the way to the regions below is every where alike open:" and in answer to

Fig. 1.

Fig. 2.

Fig. 3.

Cooper sculp.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 5.

Fig. 4.

Cooper sculp

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Cooper sculp.

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ANATOMY.

Fig. 1.

Fig. 2.

Fig. 3.

Cooper sculp

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Plate V.

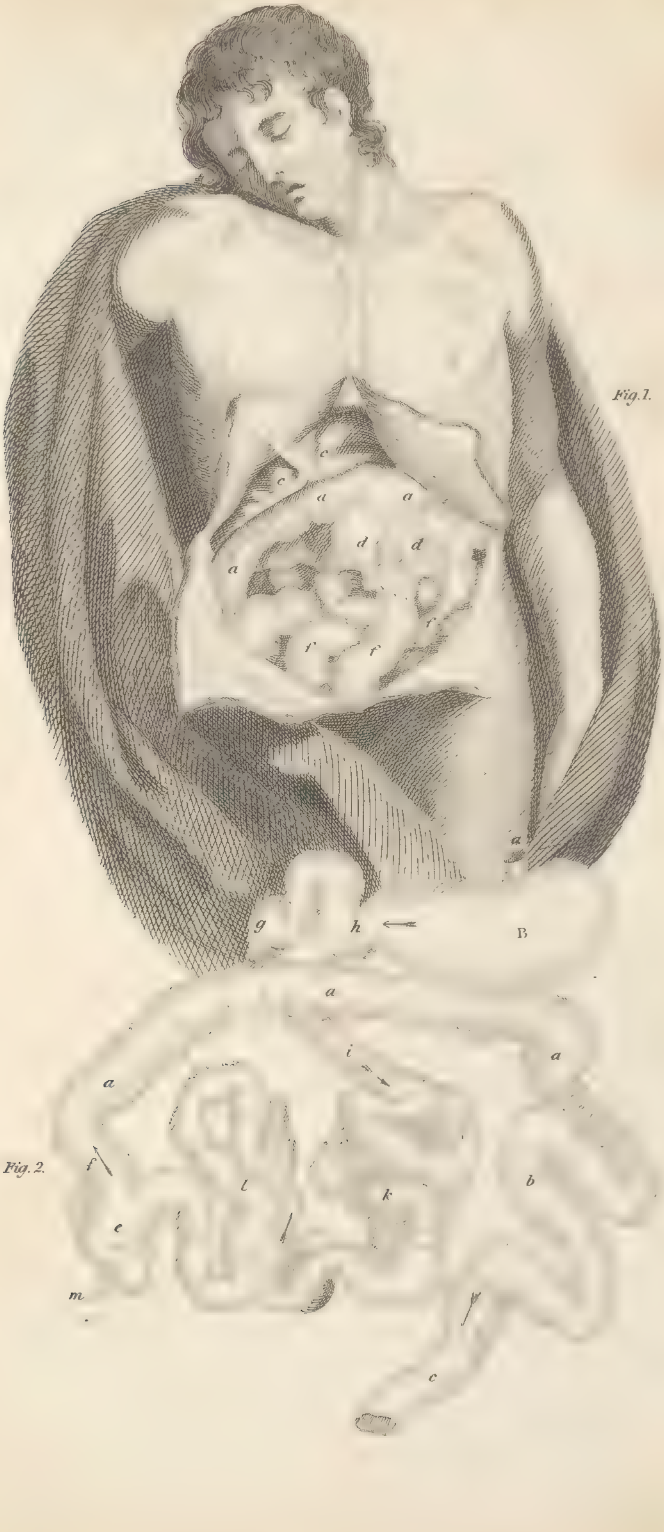

Fig. 1.

Fig. 2.

Cooper sc.

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Fig. 1.

Fig. 2.

Fig. 3.

Cooper sculp

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a message sent him at the same time by the senate of Lampsacus, requesting to be informed in what manner they might honour his memory after his decease, he said, "By ordaining the day of my death to be annually kept as a holiday in all the schools of Lampascus." This request was complied with, and a festival called Anaxagoria was instituted on the occasion.

ANAXIMANDER, in biography, a very celebrated Greek philosopher, was born at Miletus in the 42d olympiad; for, according to Apollodorus, he was 64 years of age in the second year of the 58th olympiad. He was one of the first who publicly taught philosophy, and wrote upon philosophical subjects. He was the kinsman, companion, and disciple of Thales. He wrote also upon the sphere and geometry, and framed a connected series of geometrical truths: he also wrote a summary of his doctrine, and carried his researches into nature very far, for the time in which he lived. It is said that he discovered the obliquity of the zodiac; that he first published a geographical table; that he invented the gnomon, and set up the first sun-dial in an open place at Lacedæmon. He is said to have been the first who delineated the surface of the earth, and marked the divisions of land and water upon an artificial globe. He taught, that an infinity of things was the principal and universal element; that this infinite always preserved its unity, but that its parts underwent changes; that all things came from it; and that all were about to return to it. He held that the worlds are infinite; that the stars are composed of air and fire, which are carried about in their spheres, and that these spheres are gods; that the sun has the highest place in the heavens, the moon the next, and the planets and fixed stars the lowest; that the earth is a globe, placed in the middle of the universe, and remains in its place, and that the sun is 28 times larger than the earth.

ANCHOR, in maritime affairs, an extremely useful instrument, serving to retain a ship or boat in its place.

It is a very large and heavy iron instrument, with a double hook at one end, and a ring at the other, by which it is fastened to a cable.

It is cast into the bottom of the sea, or rivers, where taking its hold, it keeps ships from being drawn away by the wind, tide, or currents.

The parts of an anchor are: 1. The ring to which the cable is fastened: 2. the beam, or shank, which is the longest part of the anchor: 3. the arm, which is that which runs into the ground: 4. the flouke or fluke, by some called the palm, the broad and peaked part, with its barbs, like the head of an arrow, which fastens into the ground: 5. the stock, a piece of wood fastened to the beam near the ring, serving to guide the fluke, so that it may fall right, and fix in the ground.

The following are the dimensions of the several parts of an anchor, as given by M. Bougier. The two arms generally form the arch of a circle, the centre of which is $\frac{3}{8}$ths of the shank from the vertex, or point where it is fixed to the shank; each arm is equal to the same length or radius, so that the two arms together make an arch of 120 degrees: the flukes are half the length of the arms, and their breadths two fifths of the said length. With respect to the thickness, the circumference at the throat or vertex of the shank is generally made about $\frac{1}{5}$th part of its length, and the small end two thirds of the throat: the small end of the arms of the flukes three fourths of the circumference of the shank of the throat.

Cast iron anchors have been proposed, and indeed from the improvements in this metal, it is probable they would be cheap and serviceable. But when we consider the great importance of anchors to the lives and property intrusted in shipping, it would not be an act of prudence to make an anchor of any material, but the very best. It appears reasonable, that a cast iron anchor, made broad in the flukes, and strong in the shank, and fortified with a kind of edge-bar, knee, or bracket, in each angle, between the arm and the shank, might prove as trust-worthy as a forged anchor, and be more than equal to the strain of any cable which is made.

There are several kinds of anchors: 1. the sheet anchor, which is the largest, and is never used but in violent storms, to hinder the ship from being driven ashore: 2. the two bowers, which are used for ships to ride in a harbour: 4. the stream anchor: 5. the grapnel. The iron of which anchors are made, ought neither to be too soft nor too brittle; for, if the iron be brittle, the anchor is apt to break, and if it be soft, the anchor will bend. In order to give them a proper temper, it is the practice to join brittle with soft iron, and for this reason, the Spanish and Swedish iron ought to be preferred.

The shank of an anchor is to be three

times the length of one of its flukes, and a ship of 500 tons hath her sheet anchor of 2000 weight; and so proportionably for others smaller or greater, although Aubin observes, that the anchors of a large vessel are made smaller in proportion than those of a small one.

The anchor is said to be a-peak, when the cable is perpendicular between the hawse and the anchor.

An anchor is said to come home when it cannot hold the ship. An anchor is foul, when, by the turning of the ship, the cable is hitched about the fluke. To shoe an anchor, is to fit boards upon the flukes, that it may hold the better in soft ground. When the anchor hangs right up and down by the ship's side, it is said to be a cock bell, upon the ship's coming to an anchor.

The inhabitants of Ceylon use large stones instead of anchors; and in some other places of the Indies, the anchors are a kind of wooden machines loaded with stones.

ANCHORAGE, in law, is a duty taken of ships for the use of the port or harbour, where they cast anchor: for the ground there belonging to the king, no man can let fall anchor thereon, without paying the king's officers for so doing.

ANCHUSA, in botany, the *alkanet*, a genus of the Pentandria Monogynia class of plants, the calyx of which is an oblong, cylindric, acute, perianthium, divided into five segments, and permanent; the corolla consists of a single petal; the tube is cylindric, and of the length of the cup; the limb is lightly divided into five segments, erecto-patent and obtuse; the opening is closed by five oblong, convex, prominent, and connivent squamulæ: there is no pericarpium: the cup becomes larger, and serves as a fruit, containing in its cavity four oblong, obtule, and gibbous seeds. There are thirteen species: though according to Martyn only ten. They are mostly biennial, except when they grow in rubbish, or out of a wall. They may all be easily propagated by seeds, sown in the autumn.

ANCISTRUM, in botany, genus of the Diandria Monogynia class and order: calyx four leaved: no corola: stigma many-parted: drupe dry, hispid, one celled. There are three species. A. decumbens resembles burnet in the herb and manner of flowering: it is remarkable for the yellow awns to the calyx, resembling fox's nails. A native of New Zealand. A. lucidum is a native of the Falkland islands, introduced here in 1777 by Dr. Fothergill; it flowers in May and June.

ANDALUSITE, or *hardspar*, in mineralogy, a species of the Felspar family, discovered by Bournon in a primitive granitic mountain in Forez. Colour flesh red, sometimes approaching to rose red. Massive, and crystallized in rectangular four-sided prisms. Specific gravity 3.16. Infusible by the blow-pipe without addition. It is distinguished from felspar by its great hardness, and higher specific gravity, and from corundum, by its inferior specific gravity and its form. It is now found in the primitive mountains in Spain and France, with quartz and mica, and sometimes in a mica state at Braunsdorf near Freyberg in Saxony.

ANDRACHNE, in botany, a genus of the Monæcia Gynandria class of plants; the corolla of the male flower is formed of five emarginated slender petals, shorter than the cup; the female flower has no corolla; the fruit is a capsule containing three cells, with two obtuse trigonal seeds, roundish on one side, and angular on the other. There are three species.

ANDRÆA, in botany, a genus of the Cryptogamia Musci class and order. Essen. char. capsule very short, turbinate: fringe simple of four incurved concave teeth, united at their tips, and bearing the lid and veil. There are two species.

ANDROIDES, in mechanics, an automaton, in the figure of a man, which, by virtue of certain springs, &c. duly contrived, walks and performs other external functions of a man. Albertus Magnus is recorded as having made a famous androides, which is said not only to have moved, but to have spoken. Thomas Aquinas is said to have been so frightened when he saw this head, that he broke it to pieces; upon which Albert exclaimed, "Periit opus triginta annorum." Artificial puppets, which, by internal springs, run upon a table, and, as they advance, move their heads, eyes, or hands, were common among the Greeks, and from thence they were brought to the Romans. Figures, or puppets, which appear to move of themselves, were formerly employed to work miracles; but this use is now superseded, and they serve only to display ingenuity, and to answer the purposes of amusement. One of the most celebrated figures, of this kind was constructed and exhibited at Paris, in 1738; and a particular account of it was published in the Memoirs of the Academy for that year. This

figure represents a flute-player, which was capable of performing various pieces of music, by wind issuing from its mouth into a German flute, the holes of which it opened and shut with its fingers: it was about $5\frac{1}{2}$ feet high, placed upon a square pedestal $4\frac{1}{2}$ feet high, and $3\frac{1}{2}$ broad. The air entered the body by three separate pipes, into which it was conveyed by nine pairs of bellows, that expanded and contracted, in regular succession, by means of an axis of steel turned by clock-work. These bellows performed their functions without any noise, which might have discovered the manner by which the air was conveyed to the machine.

The three tubes, which received the air from the bellows, passed into three small reservoirs in the trunk of the figure. Here they united, and ascending towards the throat, formed the cavity of the mouth, which terminated in two small lips, adapted in some measure to perform their proper functions. Within this cavity was a small moveable tongue, which, by its motion at proper intervals, admitted the air, or intercepted it in its passage to the flute. The fingers, lips, and tongue, derived their proper movements from a steel cylinder, turned by clock-work. This was divided into fifteen equal parts, which, by means of pegs pressing upon the ends of fifteen different levers, caused the other extremities to ascend. Seven of these levers directed the fingers, having wires and chains fixed to their ascending extremities, which, being attached to the fingers, made them to ascend in proportion as the other extremity was pressed down by the motion of the cylinder, and vice versa; then the ascent or descent of one end of a lever produced a similar ascent or descent in the corresponding fingers, by which one of the holes of the flute was occasionally opened or stopped, as it might have been by a living performer. Three of the levers served to regulate the ingress of the air, being so contrived as to open and shut, by means of valves, the three reservoirs above mentioned, so that more or less strength might be given, and a higher or lower note produced as occasion required. The lips were, by a similar mechanism, directed by four levers, one of which opened them to give the air a freer passage, the other contracted them, the third drew them backward, and the fourth pushed them forward. The lips were projected upon that part of the flute which receives the air, and, by the different motions already mentioned, modified the tune in a proper manner. The remaining lever was employed in the direction of the tongue, which it easily moves so as to shut or open the mouth of the flute. The just succession of the several motions, performed by the various parts of this machine, was regulated by the following simple contrivance. The extremity of the axis of the cylinder terminated on the right side by an endless screw, consisting of twelve threads, each placed at the distance of a line and a half from the other. Above this screw was fixed a piece of copper, and in it a steel pivot, which, falling in between the threads of the screw, obliged the cylinder to follow the threads, and, instead of turning directly round, it was continually pushed to one side. Hence, if a lever was moved, by a peg placed on the cylinder, in any one revolution, it could not be moved by the same peg in the succeeding revolution, because the peg would be moved a line and a half beyond it by the lateral motion of the cylinder.

Thus, by an artificial disposition of these pegs in different parts of the cylinder, the statue was made, by the successive elevation of the proper levers, to exhibit all the different motions of a flute-player, to the admiration of every one who saw it. Another figure, constructed by the same artist, Vaucanson, played on the Provençal shepherd's pipe, held in its left hand, and with the right beat upon a drum.

The performances of Vaucanson were imitated, and even exceeded, by M. de Kempelin, of Presburg, in Hungary. The androides constructed by this gentleman in 1769, was capable of playing chess. It was brought over to England in 1783, and remained here for more than a year. It is thus described: The figure is as large as life, in a Turkish dress, seated behind a table, with doors $3\frac{1}{2}$ feet long, 2 deep, and $2\frac{1}{2}$ high. The chair on which it sits is fixed to the table, which is made to run on four wheels. It leans its right arm on the table, and in its left hand holds a pipe; with this hand it plays after the pipe is removed. A chess-board of 18 inches is fixed before it. The table, or rather chest, contains wheels, levers, cylinders, and other pieces of mechanism, all of which are publicly displayed. The vestments of the figure was then lifted over its head, and the body seen full of similar wheels and levers. There is a little door in its thigh, which is likewise opened: and with this, and the table also open, and the figure uncovered, the whole is wheeled

about the room. The doors are then shut, and the automaton is ready to play; and it always takes the first move. At every motion the wheels are heard; the image moves its head, and looks over every part of the chess-board. When it checks the queen it shakes its head twice, and thrice in giving check to the king. It likewise shakes its head when a false move is made, replaces the piece, and makes its own move, by which means the adversary loses one. M. de Kempelin exhibited his automaton at Petersburg, Vienna, Paris, and London, before thousands, many of whom were mathematicians, and chess-players, and yet the secret by which he governed the motion of its arm was never discovered. He valued himself upon the construction of a mechanism, by which the arm could perform ten or twelve moves. It then needed to be wound up like a watch, after which it was capable of continuing the same number of motions. This automaton could not play unless M. de Kempelin, or his assistant, was near it, to direct its movements. A small square box was frequently consulted by the exhibitor during the game, and in this consisted the secret, which the inventor declared he could communicate in a moment. Any person who could beat M. de Kempelin at chess, was sure of conquering the automaton.

Remark by the Editor.—When this piece of mechanism was exhibited in London, it played a great number of moves without requiring to be wound up, and it was worked by a M. Anthon, who walked about the room without any apparent communication, during the performance. The chess-board was part of the top of the square counter, or table, to which the figure was attached in a leaning posture. When the back of the figure was opened, an upright iron axis was seen with two strong springs, which apparently were intended to restore the quiescent position after any move: and when the doors of the counter were opened, two compartments were seen, formed by an upright partition in the interior space. In one of them was seen a brass barrel, resembling that of a barrel-organ, having sixteen vertical bars or levers, so placed as if to be tripped by the barrel; and there was also some wheel-work: and in the other compartment, there was little except a brass horizontal arc, or quadrant, with a brass radius, most probably capable of being set to different angular situations. The hand of the figure lay upon a cushion, and every approaching move was announced by the discharge of a click, and the buzzing noise of a fly was heard until the move was completed. The fore-arm was first raised about two inches by a vertical motion at the elbow: it was then carried horizontally, until the hand was immediately over the piece to be taken up, at which time the fingers suddenly opened, the hand dropped, seized the piece, rose again, made the move, and dropped the piece on the square to which it had arrived. But in case the adversary's piece were to be taken, it was first seized in the manner here described, and carried clear off the board and dropped, and the subsequent move then made into the empty square. After the game was played, the Baron Kempelin gave the figure a knight, and it moved the piece in succession without any pause by the proper course, till it had passed every square in the board, as was shewn by an assistant placing a counter on each square, as the knight quitted it.

What can be deduced from so slight and transient a public view of this apparatus?—very little. It seems as if the greatest skill had been exerted in producing the mechanical effects, and that the communication of the player (Anthon) with the apparatus, may be a riddle of no great depth. The sixteen pulls from the barrel may bear some relation to the eight rows of squares, twice taken for the two sides, the white and the black; and as the moves are all reducible to those of the castle of the bishop, from which they differ in extent of shift only, (except that of the knight, which is an immediate combination of both) we may guess that the pull might determine the line to be played in, and the quadrant the distance from the back row. But it is useless to extend our conjectures, with such scanty means.

The same Baron Kempelin exhibited, in his private parlour, a small speaking instrument or organ, which he said was not then in a finished state. It was a kind of box, which he brought out and placed upon a table. Speaking without notes from the recollection of four and twenty years now elapsed, I judge its dimensions were about two feet in length, one foot wide, and eight or nine inches deep. It was open; but we were prevented from seeing the inside by a cloth put over it. The Baron put his hands under the cloth, so that his right arm was disposed longitudinally in the box, and seemed to press a pair of bellows: the other hand was put in crosswise at the end,

near the place of the right hand, and seemed to be employed with keys, or some apparatus, or perhaps both hands may have been so employed. When he made the instrument speak, he raised his right elbow, and gradually pressing it down, the sound was heard. It was monotonous, as if from a single pipe, about the pitch of D, above the middle C, concert pitch; and the words papa and mamma were uttered very distinctly, in a slow drawling manner; that is to say, there was a want of the usual inflexions of tone, and the sound fell off in intensity towards the end. After several other words had been spoken, a lady asked in French, if it could not speak sentences, and the Baron asked what it should say. She answered "*Que je suis mechante,*" and the instrument said "*Vous etes mechante, mais vous etes aussi bonne.*"

Kratzenstein has given some account of the principles of an engine of this kind, in a work extracted in the Journal de Physique; and Dr. Young has cursorily mentioned this subject in his lectures, with some diagrams.

ANDROMEDA, in astronomy, a small northern constellation, consisting of twenty-seven stars, visible to the naked eye; behind Pegasus, Cassiopeia, and Perseus. The number of stars placed in this constellation by Ptolemy is 27: by Tycho Brahe 23: by Hevelius 47; and by Flamstead 66. The constellation has been thought to resemble a woman almost naked, with her feet at a distance from each other, and her arms extended and chained.

ANDROMEDA, in botany, a genus of the Decandria Monogynia class of plants; the calyx of which is a very small acute coloured and permanent perianthium, cut into five segments; the corolla consists of a single petal, of an oval form, inflated and quinquefid; the fruit is a roundish capsule, containing five cells, in which are several roundish shining seeds. There are 25 species.

ANDROPOGON, in botany, a genus of the Polygamia Monoecia class of plants, the calyx of which is a bivalve oblong, obtuse glume; the corolla is also a bivalve glume, smaller and thinner than the cup; there is no pericarpium; the seed, which is single, oblong, covered and armed with the arista of the flower, is included in the glumes of the calyx and corolla. There are 32 species.

ANEMOMETER, among mechanical philosophers, an instrument contrived for measuring the strength of the wind. There are various kinds of anemometers: that of which Wolfius gives the structure, is moved by sails like those of a windmill. He experienced, he says, the goodness of it, and affirms that the inward structure may be preserved to measure even the force of running water, or that of men and horses when they draw. In the memoirs of the academy of sciences is described a new anemometer, which expresses on paper, not only the several winds that have blown during the space of the last 24 hours, but also the strength and velocity of each. In the Philosophical Transactions for the year 1766, Mr. Brice has described a method of measuring the velocity of the wind, by means of that of the shadow of clouds passing over the surface of the earth. This, however, in general exceeds that near the ground. M. d'Ons en Bray invented an anemometer, which of itself expresses on paper, not only the several winds that have blown during the space of 24 hours, and at what hour each began and ended, but also the strength and velocity of each. See Memoirs Acad. Scien. Anno 1734.

ANEMONE, in botany, a genus of the Polyandria Polygynia class and order. Its characters are that it has no calyx; that the corolla has petals in two or three rows, three in a row, somewhat oblong; the stamina have numerous filaments, capillary, half the length of the corolla; anthers, twin and erect: the pistillum has numerous germs in a head, styles acuminate, and stigmas obtuse; no pericarpium; receptacle globular or oblong; seeds very many, acuminate, retaining the style: there are about 30 species. The garden anemones are natives of the east, from whence their roots were originally brought; but culture has so improved them, that they are become the chief ornaments to our gardens in the spring. To prepare the soil for these plants, take a quantity of fresh, light, sandy loam, or hazel-earth, from a common or dry pasture, not dug above ten inches deep; mix this with a third part of its quantity of rotten cow-dung, and lay it up in a heap; turn this over at least once a month, for eight or ten months, and every time pick out the stones and break the clods. After this mixture has been twelve months made, it will be fit for use. The beds of this earth must be prepared in September, and should be made six or eight inches deep, in a wet soil; but in a dry one, three inches will be sufficient; lay this compost at least 2½ feet thick, with about four or five inches of rotten neat's

dung, or the rotten dung of an old melon or cucumber bed at the bottom; in a wet soil let the beds be rounded, so that the water may run off; but in a dry soil let them be nearer to a level: three weeks after the compost has been laid in, stir it about six inches deep with a spade, and then with a stick draw lines each way of the bed, at six inches distance, so that the whole may be in squares; then make a hole three inches deep in the centre of each square, and plant a root in each; and when all are planted, rake the earth of the whole bed smooth, so as to cover the roots two inches thick. The season of planting these roots for forward flowers is the latter end of September; and for those of a middle season is October: this is best done at a time when there are gentle rains. Some roots should also be saved to be planted after Christmas, for fear of accidents to the former, from very hard weather. These usually flower three weeks after those planted in autumn. They are propagated two ways, either by dividing the roots or by sowing. The roots are to be divided as soon as they are taken up out of the ground; they will succeed if broken into as many parts as there are eyes or buds in them; but they flower most strongly, if not parted too small. The way by sowing is this: choose first some good kinds of single anemones, called by the gardeners poppy anemones; plant these early, and they will produce ripe seeds three weeks after the flower first blows. This must be carefully gathered, and in August it should be sowed in pots or tubs, or a well prepared bed of light earth, rubbing it between the hands with a little dry sand, to prevent several of the seeds from clinging together, and spreading them as even as possible all over the bed; after this a light hair brush should be drawn many times over the surface of the bed, to pull asunder any lumps of seed that may yet have fallen together; observing not to brush off the seed, and as much as possible not to brush it into lumps. When this is done, some light earth, about a quarter of an inch deep, should be sifted over the bed. If the weather be hot, the bed must be at times covered with mats laid hollow, and gently watered. In about ten weeks after sowing the plants will appear, if the season has been favourable, and they are to be carefully defended from the hard frosts by proper covering, and from the heat of the sun afterwards, by a moveable reed fence. As the spring advances, if the weather be dry, they must be gently watered, and when their green leaves decay, there must be a quarter of an inch more earth sifted over them, and the like again at Michaelmas; and the bed must be kept clear from weeds, and the following spring they will flower. The single or poppy anemones will flower most part of the winter and spring, when the seasons are favourable, and in a warm situation; and they require little culture, for it will be sufficient to take up the roots every other year, and when they are taken up they should be planted again very early in the autumn, or else they will not flower till the spring. There are some fine blue colours among these single anemones, which, with the scarlets and reds, form a beautiful mixture of colours; and as these begin to flower in January or February, when the weather is cold they will continue for a long time in beauty, provided that the frost is not too severe. The seeds of these are ripe by the middle or end of May, and must be gathered daily as they ripen, because they will soon be blown away by the winds. The roots of wood anemone may be taken up when the leaves decay, and transplanted into wildernesses, where they will thrive, and in the spring have a good effect in covering the ground with their leaves and flowers. The blue anemone flowers at the same time with the foregoing, and intermixed with it, makes a fine variety. Double flowers of both these sorts have been obtained from seeds. This, and most of the other wild anemones, may be propagated by offsets from the root, which they put out plentifully; and they will grow in most soils and situations. Virginian anemone and some others, produce plenty of seeds, and may be readily increased also that way.

ANEMOSCOPE, a machine invented to tell the changes of the wind. It should consist of an idex moving about a circular plate, like the dial of a clock, on which the 32 points of the compass are drawn, instead of hours. The index, pointing to the divisions in the dial, is turned by an horizontal axis, having an handle-head at its outward extremity. This handle-head is moved by a cog-wheel on a perpendicular axis, on the top of which is fixed a vane that moves with the course of the wind, and gives motion to the whole machine. The contrivance is simple, the number of cogs in the wheel, and rounds in the trundle-head must be equal, because it is necessary, that when the vane moves entirely round, the index of the dial should also make a complete revolution. A differ-

ent anemoscope is described in the Phil. Trans. vol. xliii. part ii. and one is described in Martin's Phil. Brit. vol. ii.

ANETHUM, in botany, *dill*, a genus of the Pentandria Digynia class and order. Essen. char. fruit ovate, somewhat compressed, striate: petals involute, entire. There are three species. The common dill differs from fennel, in having an annual root, a smaller and lower stem; the leaves more glaucous, and of a less pleasant smell; the seeds broader and flatter. This plant grows wild among the corn in Spain and Portugal, and also near the coast in Italy, and near Constantinople: it is an annual, and has been cultivated here more than 200 years. The seeds are directed for use by the London and Edinburgh Pharmacopeias. Common fennel, another species of anethum, is much used for culinary purposes, and likewise in medicine.

ANEURISM, or Aneurysm, in surgery, a throbbing tumour, distended with blood, and formed by a dilatation or rupture of an artery.

ANGEL, in commerce, the name of an ancient gold coin in England, of which some are still to be seen in the cabinets of the curious. It had its name from the figure of an angel represented upon it. It was 23 $\frac{3}{4}$ carats fine, and weighed four penny-weights. Its value differed in different reigns.

ANGELICA, in botany, a genus of the Pentandria Digynia class of plants, the general umbel of which is roundish and multiple; the partial umbel, while in flower, is perfectly globose; the general involucrum is composed of either three or five leaves; the partial involucrum is small, and composed of eight leaves; the proper perianthium is small, and quinquedentate; the general corolla is uniform; the single flowers consist each of five deciduous, lanceolated, and slightly crooked petals; the fruit is naked, roundish, angular, and separable into two parts: the seeds are two, of an oval figure, plain on one side, and convex or striated on the other.

All the sorts may be increased by seeds. The common angelica delights in a moist soil, in which the seeds should be sown soon after they are ripe; and when the plants are about six inches high, they should be transplanted at a large distance, about three feet asunder, on the sides of ditches or pools of water. In the second year they will flower, and their stems may be cut down in May, and heads will be put out from the sides of the roots, and thus they may be continued for three or four years; but if they had been permitted to seed, their roots would perish soon after.—The stalks of garden angelica were formerly blanched, and eaten as celery. The young shoots are in great esteem among the Laplanders. In Norway, bread is sometimes made of the roots. The gardeners near London, who have ditches of water in their gardens, propagate great quantities of this plant, which they sell to the confectioners, who make a sweet-meat with the tender stalks cut in May. Bohemia and Spain are supposed to produce the best: the College of London, formerly directed the roots brought from Spain only to be kept in the shops. Linnæus, however, assures us, that the plant proves most vigorous on its native northern mountains, and gives a decided preference to the root dug here, either early in the spring, or late in the autumn. The roots of angelica are one of the principal aromatics of European growth, though not much regarded in the present practice. They have a fragrant agreeable smell, and a bitterish pungent taste; on being chewed they are first sweetish, afterwards acrid, and leave a glowing heat in the mouth and fauces, which continue for some time. The stalk, leaves, and seeds, appear to possess the same qualities, though in an inferior degree. Dr. Lewis says, that on wounding the fresh root early in the spring, it yields, from the inner part of the bark, an unctuous, yellowish, odorous juice, which, gently exsiccated, retains its fragrance, and proves an elegant, aromatic, gummy, resin. Rectified spirit extracts the whole of the virtues of the root; water but very little; and, in distillation with the latter, a small portion of very pungent essential oil may be obtained. The Laplanders extol the utility of angelica, not only as food but as medicine. For coughs, hoarseness, and other disorders of the breast, they eat the stalks, roasted in hot ashes; they also boil the tender flowers in dairy milk, till it attains the consistence of an extract; and they use this to promote perspiration in catarrhal fevers, and to strengthen the stomach in diarrhæa, &c. According to the explanations of Sir John Pringle, the herb is antiseptic, but the efficacy of the leaves is soon lost by drying them. The seeds also, which come nearest to the roots, can scarce be kept till the spring after they are gathered, without the loss of their vegetative power, as well as a diminution of their medicinal

virtue. These are the only parts of the plant which are ordered by the London College, and that only in compound spirit of aniseed. The aromatic quality of the root is more considerable than that of any other part; but many other simples surpass angelica in aromatic and carminative powers, it is seldom employed in the present practice. All the parts of the wild angelica are similar in quality to those of the former species, but rather weaker, and the former may be more easily procured. Cows, goats, and swine eat it, but horses refuse it.

ANGIOPTERIS, in botany, a genus of the Cryptogamia Filices. Essen. char. fructification oval, sessile, in a line near the margin of the frond, approximate in a double row, one celled.

ANGIOSPERMA, in botany, a term used by Linnæus, to express the second order of the Didynamiæ plants, which have seeds not lodged naked within the cup, as in Gymnospermia, but inclosed in a capsule, and adhering to a receptacle in the middle of a pericarp. The class of Didynamia contains the labiated and personated plants. The Angiospermia are the personated; the others the labiated kind. In this order many of the corollas are personate, or labiate, with lips closed; some, however, have bell-shaped, wheel-shaped, or triangular corollas. To have seeds inclosed in a pericarp is common to all; and hence the name of the order Angiospermia. This order contains 87 genera.

ANGLE, in geometry, the inclination of two lines meeting one another in a point, and called the legs of the angle. See GEOMETRY.

ANGLING, may be defined the art of catching fish by a rod and line, furnished with a hook and bait, or artificial fly. It is divided into two species principally, fly fishing and bait fishing: the first is performed by the use of artificial flies, which are made to imitate natural flies so exactly, that fish take them with equal eagerness. The second species of angling is effected by the application to the hook of a variety of worms, grubs, small fish, parts of fish, and a number of other matters, which shall be detailed more particularly.

Fly fishing requires more skill and address than bait fishing; and the formation of the artificial flies for it is an art in itself of so much nicety, that to give any just idea of it, we must devote an article to it particularly. See FISHING FLIES.

To constitute a good angler, a knowledge of the natural history of the fish, he desires to take, is essentially necessary; without this, he cannot perfectly know the bait most suitable to them at different seasons, and in different situations; which is so far from being obvious, that there are many small rivers which are considered as totally exhausted of their fish, by the generality of anglers, where, however, a few of extraordinary skill will find good sport, and take many fish of the best kind.

The fish which are caught by angling in this part of the world, are the salmon, salmon-fry, salmon-trout, bull-trout, or scurf, bulger trout, white trout or whitling, gravling or shedder, mullet, smelt, barbel, thunder, and eel, all which are fish of passage, making regular migrations from the sea up the rivers, and back again. So there are to be added the following sorts, which do not visit the salt water: trout, grayling, pike or jack, perch, ruff or pope, gudgeon, tench, carp, chub or botling, rudd or finscale, bream, roach, dace, bleak or bley, bulls head or millers thumb, loach, and minnow, and stickle back, which last serve chiefly for bait, a good account of the nature of all these fish, and of the rivers and lakes, where they are caught in England, Ireland, and Scotland, may be found in Taylor's Angling.

Baits for fish are principally natural; a few artificial ones are used, chiefly in fishing for pike and perch, made to imitate small fish, frogs, &c. The natural baits are whatever is commonly eaten by fish, as worms, maggots, grubs, snails, small fish, frogs, roe of fish, beetles, butter flies, moths, wasps, grasshoppers. Vegetable baits are sometimes used, as beans, wheat, barley, and peas, which last are best when green, and slightly boiled; paste made of dough, bread, or flour, mixed with oil, and a little cotton to unite it together, also forms bait. It is generally best to colour it red, particularly for smelts.

Maggots, or gentles, are best procured by hanging up a bullock's liver, scarified pretty deeply all over, covered loosely, so as to admit flies. In two or three days, living gentles will appear on it, when it should be taken down, and put into a pan, till the gentles attain their full size; a sufficient quantity of fine sand and bran is then to be put over the liver in the pan; and the gentles will in a few days come into it and scour themselves, which renders them tough, clean and fit to be handled. Those pro-

duced in autumn, will continue in that state all the winter, if they can get just under the surface of the earth. In the spring, as the weather becomes warm, they change into flies.

The cadbate is a very excellent bait, and is to be found in great plenty, in gravelly and stony rivulets; and by the side of streams in large rivers among stones; when you want them, turn up the stones, and you will find the best sticking to them. When a sufficient quantity of them are procured, hang them up in a linen bag, and dip them in the bag, once a day into water, for four or five days. They will then turn yellow, and become tough and fit for use, being much better than when they first came out of the water.

The lob or dew worm, is found in gardens and pastures, late in summer evenings, by using a lanthorn and candle. They are also dug up in fields, and by the sides of drains and ditches. To scour and preserve them for use, take some moss, dip it into clean water, wring it dry, put half of it into an earthen pot, then put in the worms, and the rest of the moss at top; cover it close, that they may not get out, and keep it in a cool place in summer, and in a warmer in winter; the moss should be changed every fifth or sixth day. In a week the worms will be fit for use. These directions will also answer for other species of worms.

Brandlings, red-worms, and gilt-heads, are found in the same dunghills together, which consist of hogs' dung, horses' dung, and rotten earth, and also in old thatch. But the worms which are found in tanner's bark, after it has been used and become quite rotten, are the best of all; but they are generally better for angling without any scouring.

Long white worms, found chiefly in turnip fields, are good bait, especially in muddy water. They are preserved best in some of their own earth, kept damp, with some moss over it.

Marsh worms, found in marshy grounds and rich banks of rivers.

The red worms, found in cow dung, and dock-worms found about the roots of docks, flags, and sedges, are all good bait. As are likewise the grubs found in cow dung, called cow-dung bobs, which are of a yellowish white, with red heads, and the short bobs, or grubs, found in mellow sandy land, which have pale red heads; yellowish tails, and bodies of the colour of the earth, wherein they are found, but which when scoured are of a pale white. These last are an excellent winter bait; the best way to render them tough, is to put them into boiling milk, for about two minutes on the morning which they are to be used.

Palmers and other grubs found by beating the branches of oaks, crab-trees, hawthorns, and others, that grow over highways, paths, and open places, and the cabbage grubs found on, and in the hearts of cabbages, are also excellent bait; these last are to be fed, and preserved with the same kind of leaves on which they are found. Salmon roe is likewise a good bait; but the numerous pastes and oils, which many have prescribed for enticing fish to bite, are, in the opinion of the most experienced anglers, only idle chimæras.

Worms are best put on hooks, by running the hooks in at the head of one worm, and out about his middle, drawing it up over the shank, and putting on a second worm beneath the first, in the middle of whose body the point of the hook is to be concealed; the tails of both worms hanging loose will entice the fish.

Ground bait is often used with good effect, particularly for barbel and for perch. It should be a general rule, that the ground bait should be always inferior to that which is used on the hook; greaves therefore should not be used, as is customary with some; but for this purpose, malt grains, bran, blood, parts of lob worms, and clay, all worked up together and made into small balls, is the most proper composition; and two or three of these balls thrown into the place, where you desire to fish, is sufficient at a time. This may be repeated now and then, but much should not be used, for if this should be done, the fish will glut themselves and become less eager for the bait on the hook.

A good ground bait is made for perch, by taking three or four balls of the stiffest clay that can be procured, making holes in them, putting one end of a lob-worm into each hole and closing the clay fast on them. These balls should then be thrown into the water about a yard from each other, when the worms, being alive in the balls, will move and twist about, which tempts the fish to feed upon them. But by angling with worms of a superior kind, the fish will on sight of them leave those in the clay, and seize the others with the greatest avidity.

The tackle necessary for angling, consists of fishing rods, lines, links of hair, and

of other materials usual; hooks, floats, spare-caps, split shot, bait of different sorts, including ground bait, shoe-makers wax, twine, silk, a clearing ring, which being passed over the rod, when the hook is entangled, and drawn down the line by a strong twine, attached to it for the purpose, to the hook or below it, if the obstruction is caused by weeds, will either free the hook or break the line near it, and prevent its being strained in any other place, by pulling the twine with sufficient force. A landing net is also useful to land large fish; and a gaff, when fishing for salmon, to be used for the same purpose; which instrument consists of a large hook attached to the end of a pliable stick; by passing the hook into the nose or gills of the fish, it may be easily lifted out of the water, for which purpose a landing net is too small. A disgorger is also necessary, to put down the throat of a fish, when he has gorged the hook, till you touch it, when on pulling the line it will be freed. The disgorger is formed by a piece of flat wood, about six inches long, and half an inch wide, forked at the ends. To these articles a fish-basket should be added, to carry the fish in.

Fishing rods are made of various lengths, according to the sort of fish they are intended for; those for salmon are about 18 feet long, those for trout 14 or 15 feet, those for pike the same as for salmon; and for other fish, either the trout or the salmon, rods may be used according to their size and strength. All rods should be made to taper evenly from the buts; and when not formed of pieces of the natural growth, which should always consist of ground shoots, they should be made of cleft timber, as sawed pieces can never be depended on. Ash or shikory are best for the lower joints, yew for the next, and the extremity of the top should always consist of whalebone; the fewer joints used in the rod the more equal will be its elasticity in every part, some have the joints formed with screw ferules, and some with sliding connections retained by plain ferules; but none are better for the elasticity of the rod and for security, than simple spliced joints, secured by well waxed twine; some recommend those latter joints to be previously glued together, before the waxed twine is applied, with glue prepared with strong lime water; but it is obvious that the wet to which rods are exposed must render glue of little use; thick white paint or some of the varnish hereafter mentioned, would probably cement the pieces together more durably. Whatever may be the number of permanent joints, the long rods need not be made to separate into more than three long pieces, and a short top; and the short rods into two pieces, and a short top; the lower joint of trout rods should be bored hollow, to contain a second top; for every trout rod should have two tops made for it; one very pliable for fly fishing, and the other stiffer for bait; the top not in use will be conveniently and safely kept in the hollow but. The rod should be furnished with rings for the line to pass through, from the top to within two feet of the reel; and when it is completed, it should be well varnished over with a varnish formed by boiling a little scraped Indian rubber, or coutchouc, in half a pint of drying linseed oil till it dissolves; the varnish should be skimmed, and be used warm. The rod, after being varnished, should be laid aside till quite dry; the varnish will then appear on it, like a fine thin bark, will be very durable, and will preserve it from being worm eaten, and from other injuries. The hollow part of the rod should be rubbed inside with linseed oil, three or four times each year, which may be done by a rag dipped in the oil, and tied to the end of a stick.

Hair lines should be long, round, clear, and free from knots, frets, or scales. For fly fishing, a line should be prepared from nine to twelve yards long, gradually tapering to the extremity. It is formed of a number of links of hair, twisted first, and then knotted to each other. The four lowest links consist of three hairs each, with the weak tops cut off all of a length; the next four links have four hairs each; the third four links five hairs; and so on till the line is completed. The links are to be knotted together with the fisherman's, or water-knot; the short ends of the hairs are to be cut off pretty close to the knots, and the knots to be whipped over with well-waxed silk. A loop should be made at each end of this line: the upper loop to fasten it to the end of the running line at the top of the rod, and the lower loop to fasten the lower links to, which should never consist of more than two or three, of either gut or hair, for fly or bottom fishing.

The best colours for lines are pale bluish, green, or watery grey, and light bay.

Running hair lines, or those all of one thickness, are made on engines prepared and sold at the fishing-tackle shops. They

may likewise be made by passing hairs through three short tubes made of quills or reeds, secured by pegs at the lower ends. The hairs are to be knotted together at the top, and the quills being then turned round all together between the fingers, will form an equal twist above them; which being drawn out according as the quills are turned round, make the line, fresh hairs being still put into the quills at the lower ends as the upper hairs are worked into the line.

The most excellent hooks are those made of the best tempered fine steel wire, longish in the shanks, and strong and rather deepish in the bend; the barbs well formed, and the point fine and straight, and as true as it can be set to be level with the shank, which last for fly fishing should be tapered off to the end of it, that the fly may be finished the neater. Hooks made in this manner, so as to lie all in one plane, are much better than twisted so as to project at one side; they do not make so large an orifice when the fish is hooked, nor are they so liable to break the hold as the others. The two kinds being fairly tried against each other for several seasons, considerably more fish were missed in the rising, and in biting at the bottom, and much more lost after being hooked with the crooked hooks than with those above recommended. The best hooks of the kind are made in Limerick.

Floats for angling are made of many kinds, as of swan quills, goose quills, Muscovy duck quills, and porcupine quills. The first is the best, when light baits are used in rivers or deep waters, and the others for slow water, or ponds not very deep. For heavy fishing, with worms or minnows, a cork float is best, made of a pyramidical form, with a quill placed in it lengthways for the line to pass through. Quil floats must carry shot enough to sink them, so as that the top may appear above water, that the slightest nibble may be better perceived. The cork floats should have sufficient shot placed beneath them on the line to make them stand upright when the shot is off the bottom, by which it may be known when the shot is on the ground; for then the float will fall on one side, and no longer stand upright.

Angling has been divided by those who have written on the subject into many other kinds besides those mentioned. Of these float angling and ground angling may be easily understood from what has been mentioned already. Night angling is performed nearly in the same way as day angling; but in it the larger and more conspicuous bait, such as garden worms, snails, and minnows, are best. Some lay long lines in rivers at night, with short lines furnished with hooks attached to them at certain intervals; and some use lines fastened to floats of various sorts; but these modes of fishing can scarcely be called angling properly speaking. The largest and finest fish are often caught by these methods.

Sea angling has nothing particular in it, but that small parts of fish are mostly used in it for bait. The same fish may be caught at the heads of piers and the mouths of rivers, and by the same bait as at sea, therefore fishing in such places is classed with sea angling.

Lastly, trimmer angling is a species of float angling. The float consists of a round piece of cork, six inches in diameter, with a groove cut at its edge, in which the line is coiled, except so much next the hook as to allow it to hang in mid-water, and so much at the other end as will reach to the bank. When a fish takes the bait, and runs with it, the line unwinds off the trimmer without giving any check; but it will be prudent to give a slight jerk to secure the fish when you come to take up the line. This method is very successful in canals, large ponds, or other still water.

Before concluding this article it will be proper to notice, that the weather has much influence on fish. When the wind is in some points few fish will bite: the most unfavourable is the eastern quarter. A warm lowering day, with flying showers, and a slight ripple on the water, is the most favourable. Water slightly disturbed prevents fish from seeing the tackle, and in it they take the bait most readily. Hence, whatever tends to disturb it so as to hide the line, without totally obscuring the bait, is of advantage. In waters affected by the tide, the flood is the best time for angling; but the ebb should not be neglected. Whirlpools, eddies, mill-tails, sides of bridges, and beneath their arches, are places where fish more readily bite, chiefly for the above reason; and in general a certain degree of darkness in the water, whether occasioned by the shade of buildings, rocks, or other bodies, or caused by the agitation of its surface, or by muddy streams flowing into it, is favourable to angling.

The proper season for fishing is in general from the beginning of spring to the end of autumn; but this depends much on the nature of the fish angled for: some may be caught at all times; others, as those of pas-

sage, are only to be met with at particular seasons; and others, though always confined to one piece of water, are nearly torpid during the winter, and are found only in deep places.

ANGUIS, in natural history, the *slow-worm*, a genus of serpents: the generic character is, scales both on the abdomen and beneath the tail. There are, according to Gmelin, 26 species. This genus is easily distinguished, by having the abdomen and under part of the tail covered with scales of a similar appearance to those on the rest of the animal, except that in some few instances they are rather larger. The body is of a shorter and more uniformly cylindric form than in the genus Coluber: the eyes are in general small, and the tail rather obtuse. No poisonous species of anguis has yet been discovered. A. fragilis, or common slow-worm, is found in almost all parts of Europe, in similar situations with the common snake, and is a perfectly innoxious animal, living on worms and insects. It is about 10 or 12 inches long: the tail measures more than half the length of the animal, and terminates pretty suddenly in a slightly acuminated tip. The slow-worm is a viviparous animal, and produces occasionally a numerous offspring: like other serpents, it varies in intensity of colours at different periods, and the young are commonly of a deeper cast than the parent animal. The general motions of the slow-worm are tardy, except when endeavouring to make its escape: it can, however, occasionally exert a considerable degree of swiftness, and can readily penetrate the loose soil in order to conceal itself from pursuit. They are often found in considerable numbers during winter, at some depth beneath the surface, and lying in a state of torpidity, and again emerging from their concealments on the approach of spring, when they cast their skin, and recover their former liveliness. If struck with violence, the body of this animal will break into pieces. A. corallina, or coral slow-worm, is a very elegant species, about 18 inches long, and of a considerable thickness: the scales are moderately large, and the head and tail are remarkably obtuse. It is a native of South America, where it is found in woods, and to prey on the larger insects, as the scolopendræ, &c.: in colour it sometimes varies; a mixture of black being blended with the red on the sides. (See Plate I. Serpentes, fig. 3.) A. ventralis, or glass slow-worm, is a handsome species about two feet long; it is a native of North America, and it takes its name from the circumstance of breaking to pieces in two or three places with a small blow of a stick, the muscles being articulated quite through the vertebræ. A. Jamaicensis, or Jamaica slow-worm, found in Jamaica about the roots of decayed trees, near ants' nests, &c. and though it has generally been deemed poisonous, yet it is really innocuous: its colour is an uniform pale brown, with a kind of silvery gloss on the scales, which are very smooth.

ANGULAR *motion*, in mechanics and astronomy, is the motion of a body which describes an angle, or which moves circularly round a point. Thus a pendulum has an angular motion about its centre of motion, and the planets have an angular motion about the sun. The angular motions of revolving bodies, as of the planets about the sun, are reciprocally proportional to their periodic times; and they are also as their real or absolute motions directly, and as their radii of motion inversely.

Angular motion is also composed of a right-lined and circular motion, or in which the moveable body slides and revolves at the same time: such is the motion of a coach-wheel.

ANGURIA, in botany, a genus of the Monoecia Diandria class and order: calyx five-cleft: corolla five-petalled: pome inferior, two-celled, many-seeded.

ANHYDRILE, in mineralogy, one of the sulphate family, found at Salz on the Neckar, in Wertemberg. Colour smalt blue, which passes into a milk white. Massive: not very brittle. Specific gravity 2.94. It differs from cube-spar in colour, fracture, shape of fragments, and in having a higher specific gravity.

ANIGOZANTHUS, in botany, a genus of the Hexandria Monogynia class and order: corolla six-parted, with unequal incurved segments: stamina inserted in the throat of the corolla: capsule three-celled, many-seeded. There is only a single species; a native of New Holland. The stem is leafy, covered at the top with reddish hairs: leaves linear: flowers umbelled: corolla clothed with reddish hairs.

ANIMAL, in natural history, an organised and living body, endowed with the powers of sensation, and of spontaneous loco-motion. Some have defined animals from their locomotion, as being capable of shifting from place to place, whereas plants adhere to the same subject. This property they assume as the great characteristic by which animals

may be distinguished from the other orders of beings. On this principle, however, oysters, muscles, cockles, &c. would be almost excluded from the class of animals, inasmuch as they usually adhere, or grow to rocks, &c. and yet it is certain that these creatures are real animals. But loco-motion alone is not sufficient to constitute the generic difference of animals; nor, indeed, does it sufficiently distinguish an animal from a plant. Many instances are produced in which plants manifest loco-motive power. This is the case with those denominated sensitive plants, many of which, upon the slightest touch, shrink back and fold up their leaves; as the snail in the slightest touch retires into its shell. There are some, on which if a fly perches, instantly close and crush the insect to death. Plants also change their position and form in different circumstances and seasons; they take advantage of good weather, and guard themselves against bad weather; they open their leaves and flowers in the day, and close them at night; some close before sun-set, and some after; some open to receive rain, and some close to avoid it; some follow the sun, and some turn from it; the leaves of some plants are in constant motion during the day, and at night they sink to a kind of rest or sleep. It has also been observed, that a plant has a power of directing its roots for procuring food; and that it has a faculty of recovering its natural position after it has been forced from it. A hop-plant, for instance, in twisting round a pole, directs its course from south to west, as the sun does; if it be tied in the opposite direction it dies; but if it be left loose in this direction, it will regain its natural course in a single night. A honey-suckle proceeds in a certain direction, till it be too long to sustain itself; it then acquires strength by shooting into a spiral form; and if it meet with another plant of the same kind, both these coalesce for mutual support, one twisting to the right and the other to the left. There are other instances in which plants manifest a faculty of loco-motion; and, perhaps, in almost as eminent a degree as some animals. Muscles, *e. g.* are fixed to one place as much as plants, nor have they any power of motion, besides that of opening and shutting their shells; nor do they seem, in this respect, to have any superiority, with regard to the powers of motion, to the sensitive plant and others of a similar kind. In order, therefore, to form a complete and satisfactory distinction between animals and vegetables, as well as minerals, it is necessary to combine with spontaneous loco-motion, which they unquestionably possess in a more perfect degree than plants, the powers of sensation. These seem to be unexceptionably distinguishing and characteristic. However, M. Buffon, after allowing that although progressive motion constitute a perceptible difference between an animal and a vegetable, this distinction is neither general or essential; proceeds to state, that sensation more essentially distinguishes animals from vegetables. But he adds, that this distinction is neither sufficiently general nor decided. If sensation, he says, implied no more than motion consequent upon a stroke or impulse, the sensitive plant enjoys this power; whereas, if by sensation we mean the faculty of perceiving, and of comparing ideas, it is uncertain whether brute animals are endowed with this faculty. If it should be allowed to dogs, elephants, &c. whose actions seem to proceed from motives similar to those by which men are actuated, it must be denied to many species of animals, particularly to those that appear not to possess the faculty of progressive motion. If the sensation of an oyster, *e. g.* differ in degree only from that of a dog, why do we not ascribe the same sensation to vegetables, though in a degree still inferior? In examining the distinction which arises from the manner of feeding, he observes, that animals have organs of apprehension, by which they lay hold of their food: they search for pasture, and have a choice in their aliment. But, it is alleged, that plants are under the necessity of receiving such nourishment as the soil affords them, without exerting any choice in the species of their food, or in the manner of acquiring it. However, if we attend to the organization and action of the roots and leaves, we shall soon be convinced that these are the external organs by which vegetables are enabled to extract their food; that the roots turn aside from a vein of bad earth, or from any obstacle which they meet with in search of a better soil; and that they split and separate their fibres in different directions, and even change their form, in order to procure nourishment to the plant. From this investigation, he concludes that there is no absolute and essential distinction between the animal and vegetable kingdoms; but that nature proceeds by imperceptible degrees, from the most perfect to the most imperfect animal, and from that to the vegetable; and that the fresh water polypus may be regarded as the

last of animals, and the first of plants. After examining the distinctions, this author proceeds to state the resemblances which take place between animals and vegetables. The power of reproduction, he says, is common to the two kingdoms, and is an analogy both universal and essential. A second resemblance may be derived from the expansion of their parts, which is likewise a common property, for vegetables grow as well as animals; and though some difference in the manner of expansion may be remarked, it is neither general nor essential. A third resemblance results from the manner of their propagation. Some animals are propagated in the same manner, and by the same means as vegetables. The multiplication of the sacceron, or vine-fritter, which is effected without copulation, is similar to that of plants by seed; and the multiplication of the polypus by cuttings resembles that of plants by slips. Hence it is inferred that animals and vegetables are beings of the same order, and that nature passes from the one to the other by imperceptible degrees; since the properties in which they resemble one another, are universal and essential; while those by which they are distinguished, are limited and partial. Dr. Watson, Bishop of Llandaff, has examined, with his usual judgment, the distinguishing marks between animals and vegetables. He rejects, as insufficient, both figure and spontaneous motion; and if perception be substituted in their stead, it will be found to be a criterion that is, in many respects, liable to exceptions. However, the ingenious and learned prelate produces many chemical, physical, and metaphysical reasons, which serve to render the supposition not altogether indefensible, that vegetables are endowed with the faculty of perception. Dr. Percival, likewise, in a paper read before the Literary and Philosophical Society of Manchester, produces several arguments to evince the perceptive power of vegetables. From the reasoning adduced by both these ingenious writers, of which a more particular account will be given in the sequel of this work (see PLANTS and VEGETABLES); those who duly advert to it, will, we conceive, incline to the opinion that plants are not altogether destitute of perception. But on a question that has perplexed and divided the most ingenious and inquisitive naturalists, it is very difficult to decide. If we extend to the vegetable kingdom that kind of vitality with which sensation and enjoyment are connected, there will remain no discernible boundary between this and the animal kingdom; and that which has been considered as the distinctive characteristic of animals, and by which they are separated from vegetables, will be abolished. We shall now add, that the principle of self-preservation belongs to all animals; and it has been argued that this principle is the true characteristic of animal life, and that it is unquestionably a consequence of sensation. There is no animal, when apprehensive of danger, that does not put itself into a posture of defence. A muscle, when it is touched, immediately shuts its shell; and as this action puts it into a state of defence, it is ascribed to a principle of self-preservation. Those who adopt this reasoning, allege that vegetables do not manifest this principle. When the sensitive plant, for instance, contracts from a touch, it is no more in a state of defence than before, for whatever would have destroyed it in its expanded state, will also destroy it in its contracted state. They add, that the motion of the sensitive plant proceeds only from a certain property called irritability; and which, though possessed by our bodies in an eminent degree, is a characteristic neither of animal or vegetable life, but belongs to us in common with brute-matter. The sensitive plant, after it has contracted, will suffer itself to be cut in pieces, without making the least effort to escape. This is not the case with the meanest animal. An hedge-hog, when alarmed, draws its body together, and expands its prickles, thus putting itself in a posture of defence: when thrown into the water, the same principle of self-preservation prompts it to expand its body and swim. A snail, when touched, withdraws itself into its shell; but if a little quick-lime be sprinkled upon it, so that its shell is no longer a place of safety, it is thrown into agonies, and endeavours to avail itself of its loco-motive power, in order to escape that danger. Muscles and oysters also, though they have not the power of progressive motion, constantly use the means which nature has given them for self-preservation. We, ourselves, possess both the animal and vegetable life, and ought to know whether there be any connection between vegetation and sensation, or not. We are conscious that we exist, that we hear, see, &c. but of our vegetation we are absolutely unconscious. We feel a pleasure in gratifying the demands of hunger and thirst; but we are totally ignorant of the process by which our aliment is formed into chyle, the chyle mixed with

the blood, the circulation of that fluid, and the separation of all the humours from it. If we, then, who are more perfect than other vegetables, are utterly insensible of our own vegetable life, why should we imagine that the less perfect vegetables are sensible of it? We have within ourselves a demonstration that vegetable life acts without knowing what it does; and if vegetables are ignorant of their most sagacious actions, why should we suppose that they have any sensation of their inferior ones; such as contracting from a touch, turning towards the sun, or advancing to a pole? As to that power of irritability which is observed in some plants, our solids have it when deprived both of animal and vegetable life; for a muscle, cut out of a living body, will continue to contract, if it be irritated by pricking, after it has neither sensation nor vegetation. Encycl. Brit. On the other hand, those who are of opinion that plants possess powers of perception, allege that their hypotheses recommends itself by its consonance to those higher analogies of nature, which lead us to conclude that the greatest possible sum of happiness exists in the universe. The bottom of the ocean is overspread with plants of the most luxuriant magnitude; and immense regions of the earth are overspread with perennial forests. Nor are the Alps or the Andes destitute of herbage, though buried in depths of snow: and can it be imagined that such profusion of life subsists without the least sensation or enjoyment? Let us rather, with humble reverence, suppose that vegetables participate, in some low degree, of the common allotment of vitality; and that one great Creator hath appointed good to all living things, in number, weight, and measure.

Animal *flower*, a name given to a variety of creatures of the Vermes tribe, that bear some resemblance to a flower. These, for the most part, belong to the order Molluscæ; the name is, however, frequently given to a different order, *viz.* the Zoophytes.

Animal *manures*, in agriculture, are all substances that are formed from the decomposition of animal substances of any kind; as the muscles, blood, hair, wool, bones, fat, &c. These are generally esteemed as more powerful, in promoting vegetation, than such as are derived from vegetable matters. On account, however, of their being but seldom procured in large quantities, they are generally made use of in the state of mixture or combination with other materials. By the action of ammonia, which is constantly formed during the decomposition of animal substances, the mould is made more suitable for plants.

Animal, *parts of*, substances which compose the bodies of animals may be arranged under the following heads:

1. Bones and shells
2. Horns and nails
3. Muscles
4. Skin
5. Membranes
6. Tendons and ligaments
7. Glands
8. Brain and nerves
9. Hair and feathers
10. Silk and similar bodies.

Besides these substances which constitute the solid part of the bodies of animals, there are a number of fluids, the most important of which is the blood, which pervades every part of the system in all the larger animals: the rest are known by the name of secretions, because they are formed or secreted, as the anatomists term it, from the blood. The principal animal secretions are the following:

1. Milk
2. Eggs
3. Saliva
4. Pancreatic juice
5. Bile
6. Cerumen
7. Tears
8. Liquor of the pericardium
9. Humours of the eye
10. Mucus of the nose, &c.
11. Sinovia
12. Semen
13. Liquor of the amnios
14. Poisonous secretions.

Various substances are separated either from the blood or the food, on purpose to be afterwards thrown out of the body as useless or hurtful. These are called excretions. The most important of them are,

1. Urine
2. Fæces.

Besides the liquids which are secreted for the different purposes of healthy animals, there are others which make their appearance only during disease, and which may therefore be called morbid secretions. The most important of these are the following:

1. Pus
2. The liquor of dropsy
3. The liquor of blisters.

To these we must add several solid bodies, which are occasionally formed in different cavities, in consequence of the deceased action of the parts. They may be called morbid concretions. The most remarkable of them are the following:

1. Salivary calculi
2. Concretions in the lungs, liver, brain, &c.
3. Intestinal calculi
4. Biliary calculi
5. Urinary calculi
6. Gouty calculi.

Animal *substances*, or those which have hitherto been detected in the animal kingdom, and of which the different parts of animals, as far as these have been analysed, are found to be composed, may be arranged under the following heads:

1. Gelatine
2. Albumen
3. Mucus
4. Fibrin
5. Urea
6. Saccharine matter
7. Oils
8. Resins
9. Sulphur
10. Phosphorus
11. Acids
12. Alkalies
13. Earths
14. Metals.

See the several articles in their alphabetical order.

Animal, *functions of.* See Assimilation, Digestion, Perspiration, Respiration, &c.

Animals, *generation of.* See the article Generation.

Animals in heraldry, are much used, both as bearings and supporters. It is to be observed, that in blazoning animals must be interpreted in the best sense, and so as to redound to the greatest honour of the bearers. For example, the fox being renowned for wit, and likewise given to filching for his prey; if this be the charge of an escutcheon, we must conceive the quality represented to be his wit, and not his theft. All beasts must be figured in their most noble action; as a lion rampant, a leopard or wolf passant, a horse running or vaulting, a greyhound coursing, a deer tripping, and a lamb going with a smooth pace. In like manner, every animal must be moving and looking to the right side of the shield, the right foot being placed foremost. These are the precepts given by Guillim, and yet we find that there are lions passant, couchant, and dormant, as well as rampant.

ANIMALCULE, an animal so minute in its size, as not to be the immediate object of our senses.

Animalcules are usually divided into two distinct sections, visible, and microsopical. The first, though visible, cannot be accurately discerned without the help of glasses: the second are discoverable only by the microscope. Some have supposed there are others invisible. The existence of these cannot well be disputed, though it cannot be asserted, unless we conclude, that the microscope has not yet arrived at its highest degree of perfection. Reason and analogy give some support to the conjectures of naturalists in this respect: animalcules are discerned of various sizes, from those which are visible to the naked eye, to such as appear only like moving points under the microscopic lenses of the greatest powers; and it is not unreasonable to imagine, therefore, that there are others which may still resist the action of the microscope, as the fixed stars do that of the telescope, with the greatest powers hitherto invented.

Animalcules, visible; amongst these are included an amazing variety of creatures, by no means of analagous natures. Those numerous creatures which crowd the water in the summer months, changing it sometimes of a deep or pale red colour, green, yellow, &c. are of this description. The large kinds are chiefly of the insect, or vermes tribes, and of which the monoculus pulex is particularly remarkable, being sometimes found in such abundance, as to change the water apparently to a deep red. A similar appearance is likewise occasioned by the circaria mutabilis, when it varies in colour from green to red; vorticella fasciculata also changes it to green; and rotatoria to yellow. To this section we must also refer many of the acarus and hydrachna genera, and a multitude of other creatures that will be noticed hereafter.

Animalcules, microscopical. The microscope discovers legions of animalcules in most liquors, as water, vinegar, beer, dew, &c. They are also found in rain and several chalybeate waters, and in infusions of both animal and vegetable substances, as the seminal fluids of animals, pepper, oats, wheat and other grain, tea, &c. &c. The contemplation of animalcules has made the ideas of infinitely small bodies extremely familiar to

us. A mite was anciently thought the limit of littleness; but we are not now surprised to be told of animals twenty-seven millions of times smaller than a mite. Minute animals are found proportionably much stronger, more active and vivacious than large ones. The spring of a flea in its leap, how vastly does it outstrip any thing greater animals are capable of! A mite, how vastly faster does it run than a race-horse! M. de l'Isle has given the computation of the velocity of a little creature scarcely visible by its smallness; which he found to run three inches in half a second: supposing now its feet to be the fifteenth part of a line, it must make five hundred steps in the space of three inches; that is, it must shift its legs five hundred times in a second, or in the ordinary pulsation of an artery. The excessive minuteness of microscopical animalcules conceals them from the human eye. One of the wonders of modern philosophy is, to have invented means for bringing creatures to us so imperceptible under our cognizance and inspection: an object a thousand times too little to be able to affect our sense should seem to have been very safe. Yet we have extended our views over animals, to whom these would be mountains. In reality, most of our microscopical animalcules are of so small a magnitude, that through a lens, whose focal distance is the tenth parth of an inch, they only appear as so many points; that is, their parts cannot be distinguished, so that they appear from the vertex of that lens under an angle not exceeding a minute. If we investigate the magnitude of such an object, it will be found nearly equal to $\frac{3}{100000}$ of an inch long. Supposing, therefore, these animalcules of a cubic figure, that is of the same length, breadth, and thickness, their magnitude would be expressed by the cube of the fraction $\frac{3}{100000}$, that is, by the number $\frac{27}{1000,000,000,000,000}$, that is, so many parts of a cubic inch, is each animalcule equal to. Leeuwenhoeck calculates, that a thousand millions of animalcula, which are discovered in common water, are not altogether so large as a grain of sand. This author, upon examining the male sperm of various animals, discovered in many infinite numbers of animalcula not larger than those above mentioned. In the milt of a single cod fish there are more animals than there are upon the whole earth; for a grain of sand is bigger than four millions of them. The white matter that sticks to the teeth also abounds with animalcules of various figures, to which vinegar is fatal; and it is known, that vinegar contains animalcules in the shape of eels. In short, according to this author, there is scarcely any thing which corrupts without producing animalcules. Animalcules are said to be the cause of various disorders. The itch is known to be a disorder arising from the irritation of a species of animalcula found in the pustules of that ailment: when the communication of it by contact from one to another is easily conceived, as also the reason of the cure being effected by cutaneous applications. In the Philosophical Transactions, vol. lix., is a curious account of the animalcules produced from an infusion of potatoes, and another of hemp-seed, by the late Mr. Ellis." "On the 25th of May, 1768, Fahrenheit's thermometer 70°, I boiled a potatoe in the New River water, till it was reduced to a mealy consistence. I put part of it, with an equal proportion of the boiling liquor, into a cylindrical glass vessel, that held something less than half a wine-pint, and covered it close immediately with a glass cover. At the same time I sliced an unboiled potatoe, and, as near as I could judge, put the same quantity into a glass vessel of the same kind, with the same proportion of New River water not boiled; and covered with a glass cover, and placed both vessels close to each other." "On the 26th of May, 24 hours afterwards, I examined a small drop of each by the first magnifier of Wilson's microscope, whose focal distance is reckoned at $\frac{1}{50}$ part of an inch; and, to my amazement, they were both full of animalcula, of a linear shape, very distinguishable, moving to and fro with great celerity, so that there appeared to be more particles of animal than vegetable life in each drop." "This experiment I have repeatedly tried, and always found it to succeed in proportion to the heat of the circumambient air; so that even in winter, if the liquors are kept properly warm, at least in two or three days the experiment will succeed." "I procured hemp-seed from different seeds-men in different parts of the town. Some of it I put into the New River water, some into distilled water, and some into very hard pump-water. The result was, that in proportion to the heat of the weather, or warmth in which they were kept, there was an appearance of millions of minute animalcula in all the infusions; and, some time after, oval ones made their appearance. These were much larger than the first, which still continued: these wrig-

gled to and fro in an undulatory motion, turning themselves round very quick all the time they moved forwards.

ANIME, a resin obtained from the hymenæa courbaril, or locust-tree, which is a native of North America. It resembles copal very much in its appearance, but is readily soluble in alcohol, which copal is not. It is used as a varnish. Alcohol dissolves it completely; and distilled over, it acquires both the smell and taste of anime.

ANNALS, in matters of literature, a species of history, which relates events in the chronological order wherein they happened. They differ from perfect history in this, that annals are a bare relation of what passes every year, as a journal is of what passes every day; whereas history relates not only the transactions themselves, but also the causes, motives, and springs of actions. Annals require nothing but brevity, history demands ornament. Cicero informs us of the origin of annals: to preserve the memory of events, the pontifex maximus, says he, wrote what passed each year, and exposed it on tablets in his own house, where every one was at liberty to read: this they called *annales maximi;* and hence the writers who imitated this simple method of narrating facts were called annalists.

ANNATES, among ecclesiastical writers, a year's income of a spiritual living. These were, in ancient times, given to the pope throughout all christendom, upon the decease of any bishop, abbot, or parish-clerk, and were paid by his successor. In England, the pope claimed them first of such foreigners as he conferred benefices upon, by way of provision; but afterwards they were demanded of all other clerks on their admission to benefices. At the reformation they were taken from the pope, and vested in the king; and finally, queen Anne restored them to the church, by appropriating them to the augmention of poor livings.

ANNEALING, or NEALING, the burning or baking glass, earthen-ware, &c. in an oven or furnace. See GLASS.

ANNOTATION, in matters of literature, a brief commentary, or remark upon a book or writing, in order to clear up some passage, or draw some conclusion from it: thus the critics of the last age have made learned annotations upon all the classics.

ANNOTTO, in commerce, a kind of red dye, brought from the West Indies. This is otherwise denominated arnatto. It is procured from the pulp of the seed-capsules of a shrub called achiotte and urucu; the bixa orellana of Linnæus, which grows seven or eight feet high, and produces oblong hairy pods, somewhat resembling those of a chesnut. Within each of these are thirty or forty irregularly figured seeds, which are enveloped in a pulp of a bright red colour, and unpleasant smell, somewhat resembling the paint called red lead when mixed up with oil; and it was used as paint by some of the Indians, in the same manner as woad was used by the ancient Britons. The seeds, together with the red tough matter that surrounds them, are softened in a wooden trough with water, until, by a kind of fermentation, which spreads a very nauseous smell, and by diligent stirring and pounding, the kernels are separated from the pulp. This mass is then strained through a seive, and boiled; and upon which a thick reddish scum, which is the pigment, separates. When skimmed off, it is carefully inspissated in another kettle; and after being repeatedly cool, is moulded in roundish lumps, wrapt round with leaves of trees, and packed for sale. It seems to partake of the nature of vegetable albuminous matter. The method of extracting the pulp, and preparing it for market, is simply by boiling the seeds in clear water, till they are perfectly extricated; after which the seeds are taken out, and the water left undisturbed for the pulp to subside. It is then drained off, and the sediment distributed into shallow vessels, and dried generally in the shade. The annotto is now only prepared by the Spaniards. The English had formerly a manufacture at St. Angelo, now ruined. This drug is preferred by the dyers to indigo, and sold one-fourth dearer. The double Gloucester cheese is coloured with this dye, not with marygolds. Some of the Dutch farmers use it to give a rich colour to their butter, and great quantities are said to be applied to the same purpose in the English dairies. The poor people use it instead of saffron; and it is sometimes mixed as an ingredient in chocolate, during the grinding of the cocoa, in the quantity of about two drams to the pound, in order to give it a reddish colour; but the opinion of its being an earth has brought it into dispute, and this use of it has been discontinued. To water it gives only a pale brownish yellow colour, and is not soluble in that liquid, nor in spirit of wine; but, in order to be fit for dyeing, it requires an alkaline menstruum, to which it gives a bright orange colour; and hence it is useful as an ingredient in varnishes and lacquers, and in

dyeing wax of a vermillion colour. Wool and silk, boiled in a solution of it by alkaline salts in water, acquire a deep, but not a durable orange dye; for though it is not changed by alum or acids, it is discharged by soaps, and destroyed by exposure to the air. It is said to be an antidote to the poisonous juice of manihot, or cassada. The liquid sold under the name of "Scott's nankeen dye," seems to be nothing but annotto dissolved in alkaline ley.

ANNOYANCE, in law, any injury done to a public place, as a high-way, bridge, or common river; or to a private way, as laying any thing that may breed infection, by encroaching, &c.

ANNUAL *plants*, generally called annuals, in gardening, signify such plants as are of one year's duration, or which continue for a few months only. Plants that rise from seed sown in the spring, arrive at maturity in the summer or autumn following, producing flowers and ripe seed, and which afterwards perish in their tops and roots, are commonly regarded as annuals. The plants of this tribe are very numerous, as most of those of the herbaceous kinds, consisting of uncultivated plants, weeds, &c. and also a great number of cultivated garden and field plants, both of the esculent and flowery ornamental kinds, are of this description. The last sort are often termed simply annuals. These are divided into the hardy and tender kinds; the former are sown in places where they are designed to remain without transplanting, but the latter are usually sown in hot-beds, in order to be transplanted in the spring, either into pots or borders.

ANNUITIES, any income of a certain yearly amount, payable at particular periods, which may be either yearly, half-yearly, quarterly, monthly, weekly, or at any other intervals. They are usually distinguished into annuities certain, and contingent annuities, or such as are for an uncertain period, being determinable by some future event, such as the failure of a life or lives.

The present value of an annuity is that sum which, if improved at compound interest, would be sufficient to pay the annuity: the present value of an annuity certain, payable yearly, and of which the first payment is to be made at the end of a year, may therefore be calculated in the following manner.

Suppose a person has 100*l.* due to him a twelvemonth hence, and he wishes to have the value of the same advanced immediately the sum which ought to be given as an equivalent thereto, allowing 5 per cent. interest, is 95*l.* 4*s.* 9¼*d.* for this is the sum which, put out to interest at the rate of 5 per cent. will, at the end of the year, amount to 100*l.* So also, if a person has 100*l.* due to him at the end of two years, and he wishes to have the value of the same advanced immediately, the sum which ought to be given as an equivalent thereto is 90*l.* 14*s.* 0¾*d.* for this is the sum which, put out at the same rate of interest, will, at the end of two years, amount to 100*l.* In like manner, if a person has 100*l.* due to him at the end of three years, and he wishes to have the same advanced immediately, the sum which ought to be given as an equivalent thereto is 86*l.* 7*s.* 8*d.* for this is the sum which, at the same rate of interest, will at the end of three years amount to 100*l.* And if these three values are added together, they will make 272*l.* 6*s.* 6*d.* being the sum which ought to be paid down for an annuity of 100*l.* for three years; as this sum improved at the given rate of interest is just sufficient to make the three yearly payments.

As the amount or present worth of 1*l.* for any given term is usually adopted as the foundation of calculations relating to annuities; let r represent the amount of 1*l.* in one year; that is, one pound increased by a year's interest, then r^n, or r raised to the power whose exponent is any given number of years, will be the amount of 1*l.* in those years; its increase in the same time is $r^n - 1$; now the interest for a single year, or the annuity corresponding with the increase, is $r - 1$; therefore, as $r - 1$ is to $r^n - 1$, so is u (any given annuity) to a its amount: hence we have

$$\frac{u \times \overline{r^n - 1}}{r - 1} = a$$

EXAMPLE.—To what sum will an annuity of 50*l.* amount in 6 years, at 5 per cent. per annum compound interest?

$$\frac{50 \times \overline{1.05^6 - 1}}{.05} = 340l.\ 19s.\ 1d.$$

In this manner the amount of an annuity for any number of years, at any given rate of interest, may be found. But when the term of years is considerable, it will be more convenient to work by logarithms, by which the labour of all calculations relating to compound interest is greatly abridged. There is, however, little occasion in general to calculate the amount or present worth of annuities, except for particular rates of interest, as the following tables, and others of

a similar nature, for different rates of interest which are given in most books on compound interest, save much time and labour in common practice, and are therefore in general use.

TABLE I.

Shewing the amount of an annuity of 1*l.* in any number of years not exceeding 100, at 5 per cent. per annum compound interest.

Yrs.	Amo.	Yrs.	Amount.	Yrs.	Amount.
1	1,0000	35	90,3203	69	559,5510
2	2,0500	36	95,8363	70	588,5285
3	3,1525	37	101,6281	71	618,9549
4	4,3101	38	107,7095	72	650,9027
5	5,5256	39	114,0950	73	684,4478
6	6,8019	40	120,7998	74	719,6702
7	8,1420	41	127,8398	75	756,6537
8	9,5491	42	135,2317	76	795,4864
9	11,0266	43	142,9933	77	836,2607
10	12,5779	44	151,1430	78	879,0738
11	14,2068	45	159,7002	79	924,0274
12	15,9171	46	168,6852	80	971,2288
13	17,7130	47	178,1194	81	1020,7903
14	19,5986	48	188,0254	82	1072,8298
15	21,5786	49	198,4267	83	1127,4713
16	23,6575	50	209,3480	84	1184,8448
17	25,8404	51	220,8154	85	1245,0871
18	28,1328	52	232,8562	86	1308,3414
19	30,5390	53	245,4990	87	1374,7585
20	33,0659	54	258,7739	88	1444,4964
21	35,7192	55	272,7126	89	1517,7212
22	38,5052	56	287,3482	90	1594,6073
23	41,4305	57	302,7157	91	1675,3377
24	44,5020	58	318,8514	92	1760,1045
25	47.7271	59	335,7940	93	1849,1098
26	51,1135	60	353,5837	94	1942,5653
27	54,6691	61	372,2629	95	2040,6935
28	58,4026	62	391,8760	96	2143,7282
29	62,3227	63	412,4698	97	2251,9146
30	66,4388	64	434,0933	98	2365,5103
31	70,7608	65	456,7980	99	2484,7859
32	75,2988	66	480,6379	100	2610,0252
33	80,0638	67	505,6698		
34	85,0670	68	531,9533		

Example 1.—To what sum will an annuity of 105*l.* amount in 19 years, at 5 per cent. compound interest?

The number in the table opposite to 19 years is 30,5390, which multiplied by 105 gives the answer 3206*l.* 11*s.* 10*d.*

Example 2.—In what time will an annuity of 25*l.* amount to 3575*l.* at 5 per cent. compound interest?

Divide 3575*l.* by 25*l.* the quotient is 143; the number nearest to this in the table is 142,9933, and the number of years corresponding, or 43 years, is the answer.

The present worth of an annuity, or the sum to be given in one present payment as an equivalent for an annuity for any given number of years, is found on similar principles; for as 1*l.* is the present value of r_n (its amount in n years, and as the present value of any other amount, and consequently of $\frac{u \times r_n - 1}{r - 1}$ must bear the same proportion to that amount, we have

$$\frac{u - \frac{u}{r^n}}{r - 1} = p.$$

Example.—What is the present value of 50*l.* per annum for 6 years, at 5 per cent. compound interest?

$$\frac{50 - \frac{50}{\overline{1.05}|^6}}{.05} = 253l.\ 15s.\ 8d.$$

But such questions are much more readily answered by the following table.

TABLE II.

Shewing the present value of an annuity of 1*l.* for any number of years not exceeding 100, at 5 per cent. per annum compound interest.

Y.	Value.	Y.	Value.	Y.	Value.
1	,952381	35	15,374194	69	19,309810
2	1,859410	36	16,546852	70	19,342677
3	2,723248	37	16,711287	71	19,373978
4	3,545950	38	16,867893	72	19,403788
5	4,329477	39	17,017041	73	19,432179
6	5,075692	40	17,159086	74	19,459218
7	5,786373	41	17,294368	75	19,484970
8	6,463213	42	17,423208	76	19,509495
9	7,107822	43	17,545912	77	19,532853
10	7,721735	44	17,662773	78	19,555098
11	8,306414	45	17,774070	79	19,576284
12	8,863252	46	17,880066	80	19,596460
13	9,393573	47	17,981016	81	19,615677
14	9,898641	48	18,077158	82	19,633978
15	10,379658	49	18,168722	83	19,651407
16	10,837770	50	18,255925	84	19,668007
17	11,274066	51	18,338977	85	19,683816
18	11,689587	52	18,418073	86	19,698873
19	12,085321	53	18,493403	87	19,713212
20	12,462210	54	18,565146	88	19,726869
21	12,821153	55	18,633472	89	19,739875
22	13,163003	56	18,698545	90	19,752262
23	13,488574	57	18,760519	91	19,764059
24	13,798642	58	18,819542	92	19,775294
25	14,093945	59	18,875754	93	19,785994
26	14,375185	60	18,929290	94	19,796185
27	14,643034	61	18,980276	95	19,805891
28	14,898127	62	19,028834	96	19,815134
29	15,141074	63	19,075080	97	19,823937
30	15,372451	64	19,119124	98	19,832321
31	15.592810	65	19,161070	99	19,840306
32	15,802677	66	19,201019	100	19,847910
33	16,002549	67	19,239066		
34	16,192904	68	19,275301		

EXAMPLE 1.—What is the present value of an annuity of 63*l.* to continue for 21 years?

The value in the table against 21 years is 12,821153, which multiplied by 63 gives the answer 807*l.* 14*s.* 7*d.*

EXAMPLE 2.—What present sum is equivalent to a nett rent of 20*l.* per annum for 69 years?

The value in the table against 69 years is 19,309810, which multiplied by 20 gives the answer 386*l.* 3*s.* 11*d.*

If any of the annuities in the above table, instead of being for an absolute term of years, had been subject to cease if a given life should fail during the term, it is evident that the value would have been lessened in proportion to the probability of the life failing; and, that if instead of being for a certain number of years, the annuity depended wholly on the uncertain continuance of a given life or lives, its value must be ascertained by the probable duration of such life or lives. In order to compute the value of LIFE ANNUITIES, therefore, it is necessary to have recourse to tables that exhibit the number of persons, which, out of a certain number born, are found to be living at the end of every subsequent year of human life, which thus shew what are termed the probabilities of life.

Various tables of this kind have been formed by the different writers on this subject, as Dr. Halley, Mr. Thomas Simpson, M. Kersseboom, M. De Parcieux, Dr. Price, Dr. Haygarth, Mr. Wargentin, M. Susmilch, and others; and the true method of computing the value of life annuities according to the probabilities of any table of mortality is laid down by Mr. William Morgan as follows:

"Was it *certain* that a person of a given age would live to the end of a year, the value of an annuity of 1*l.* on such a life would be the present sum that would increase in a year to the value of a life one year older, together with the value of the single payment of 1*l.* to be made at the end of a year; that is, it would be 1*l.* together with the value of a life aged one year older than the given life, multiplied by the value of 1*l.* payable at the end of a year. Call the value of a life one year older than the given life N, and the value of 1*l.* payable at the end of a year $\frac{1}{r}$; then will the value of an annuity on the given life, on the supposition of a *certainty*, be $\frac{1}{r}+\frac{1}{r}\times N=\frac{1}{r}\times\overline{1+N}$. But the fact is, that it is uncertain whether the given life will exist to the end of the year or not, this last value, therefore, must be diminished in the proportion of this uncertainty, that is, it must be multiplied by the probability that the given life will survive one year, or supposing $\frac{b}{a}$ to express this probability, it will be $\frac{b}{ar}\times\overline{1-N}$."

The values of annuities on the joint continuance of two lives are found by reasoning in a similar manner; and such values, both for single and joint lives, are given in the following tables.

TABLE III.

Shewing the value of an annuity of 1*l.* on a single life, at every age, according to the probabilities of the duration of life at Northampton, reckoning interest at 5 per cent. per annum.

Age.	Value.	Age.	Value.	Age.	Value.
Birth.	8,863	33	12,740	66	7,034
1 year	11,563	34	12,623	67	6,787
2	13,420	35	12,502	68	6,536
3	14,135	36	12,377	69	6,281
4	14,613	37	12,249	70	6,023
5	14,827	38	12,116	71	5,764
6	15,041	39	11,979	72	5,504
7	15,166	40	11,837	73	5,245
8	15,226	41	11,695	74	4,990
9	15,210	42	11,551	75	4,744
10	15,139	43	11,407	76	4,511
11	15,043	44	11,258	77	4,277
12	14,937	45	11,105	78	4,035
13	14,826	46	10,947	79	3,776
14	14,710	47	10,784	80	3,515
15	14,588	48	10,616	81	3,263
16	14,460	49	10,443	82	3,020
17	14,334	50	10,269	83	2,797
18	14,217	51	10,097	84	2,627
19	14,108	52	9,925	85	2,471
20	14,007	53	9,748	86	2,328
21	13,917	54	9,567	87	2,193
22	13,833	55	9,382	88	2,080
23	13,746	56	9,193	89	1,924
24	13,658	57	8,999	90	1,723
25	13,567	58	8,801	91	1,447
26	13,473	59	8,599	92	1,153
27	13,377	60	8,392	93	0,816
28	13,278	61	8,181	94	0,524
29	13,177	62	7,966	95	0,238
30	13,072	63	7,742	96	0,069
31	12,965	64	7,514		
32	12,854	65	7,276		

The values in this and the following tables, suppose the payments to be made yearly, and to begin at the end of a year; but if all the payments are to be half-yearly pay-

ments, and to be made at the end of every half-year from the time of purchase, the value will be increased about one-fifth of a year's purchase.

The above table is formed from the probabilities of life, as deduced from the register of mortality at Northampton for 46 years, from 1735 to 1780; and as it gives the mean values of lives between the highest and lowest, it is better adapted for general use than any other extant. It has of late years been generally adopted for calculating the rates of assurance on lives, and is well suited to this purpose; but it is by no means a proper table for individuals or societies to grant life annuities from, for having been formed from a register comprehending persons of all ages and conditions, it cannot give a correct representation of the duration and value of such lives as usually form a body of annuitants, such persons being generally a selection of the best lives from the common mass, the interest of every person who purchases an annuity on any life requiring that he should take care that it is a good life. The best table for regulating the grant of life annuities, is that formed from the table of mortality published by Mr. De Parcieux, from the lists of the French tontines, but even this table gives the values of the advanced ages considerably too low.

TABLE IV.

Shewing the value of an annuity of 1*l.* on a single life, at every age, according to the probabilities of life, in Mr. De Parcieux's table of the mortality. Interest at 5 per cent.

Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.
0	11,083	18	15,631	36	14,065	54	10,418	72	5,540
1	14,620	19	15,550	37	13,930	55	10,168	73	5,232
2	15,135	20	15,474	38	13,786	56	9,930	74	4,942
3	15,509	21	15,401	39	13,632	57	9,682	75	4,674
4	15,750	22	15,328	40	13,466	58	9,431	76	4,429
5	15,924	23	15,256	41	13,296	59	9,177	77	4,190
6	16,041	24	15,184	42	13,116	60	8,923	78	3,953
7	16,118	25	15,112	43	12,931	61	8,669	79	3,719
8	16,169	26	15,040	44	12,738	62	8,413	80	3,501
9	16,204	27	14,969	45	12,539	63	8,155	81	3,283
10	16,210	28	14,893	46	12,333	64	7,893	82	3,072
11	16,194	29	14,810	47	12,119	65	7,626	83	2,868
12	16,145	30	14,722	48	11,897	66	7,351	84	2,668
13	16,077	31	14,627	49	11,666	67	7,069	85	2,461
14	15,994	32	14,527	50	11,425	68	6,778	86	2,237
15	15,901	33	14,421	51	11,178	69	6,479	87	1,976
16	15,807	34	14,306	52	10,926	70	6,171	88	1,688
17	15,716	35	14,189	53	10,673	71	5,856	89	1,409
								90	1,164

The calculation of the values of joint lives from any given table of mortality, for every combination of age, is so laborious a task that no such table has yet been published. Mr. Simpson, in his select exercises, gave a table of the values of two joint lives, agreeable to the probabilities of life in London; but the tables founded on the London bills, representing the rate of mortality among the inhabitants, taken in the gross, give the values of lives much too low for the middling and superior classes of the people in London itself, and are wholly improper for general use. A much more comprehensive table of the value of joint lives, has since been calculated by Dr. Price from the Northampton table of mortality, from which the following table is taken.

TABLE V.

Shewing the value of an annuity of 1*l.* on the joint continuance of two lives, according to the probabilities of life at Northampton. Interest at 5 per cent.

Ages.	Value.	Ages.	Value.	Ages.	Value
5-5	11,984	20-25	10,989	40-45	8,643
5-10	12,315	20-30	10,707	40-50	8,177
5-15	11,954	20-35	10,363	40-55	7,651
5-20	11,561	20-40	9,937	40-60	7,015
5-25	11,281	20-45	9,448	40-65	6,240
5-30	10,959	20-50	8,861	40-70	5,298
5-35	10,572	20-55	8,216	40-75	4,272
5-40	10,102	20-60	7,463	40-80	3,236
5-45	9,571	20-65	6,576	45-45	8,312
5-50	8,941	20-70	5,532	45-50	7,891
5-55	8,256	20-75	4,424	45-55	7,411
5-60	7,466	20-80	3,325	45-60	6,822
5-65	6,546	25-25	10,761	45-65	6,094
5-70	5,472	25-30	10,499	45-70	5,195
5-75	4,362	25-35	10,175	45-75	4,206
5-80	3,238	25-40	9,771	45-80	3,197
10-10	12,665	25-45	9,304	50-50	7,522
10-15	12,302	25-50	8,739	50-55	7,098
10-20	11,906	25-55	8,116	50-60	6,568
10-25	11,627	25-60	7,383	50-65	5,897
10-30	11,304	25-65	6,515	50-70	5,054
10-35	10,916	25-70	5,489	50-75	4,112
10-40	10,442	25-75	4,396	50-80	3,140
10-45	9,900	25-80	3,308	55-55	6,735
10-50	9,260	30-30	10,255	55-60	6,272
10-55	8,560	30-35	9,954	55-65	5,671
10-60	7,750	30-40	9,576	55-70	4,893
10-65	6,803	30-45	9,135	55-75	4,006
10-70	5,700	30-50	8,596	55-80	3,076
10-75	4,522	30-55	7,999	60-60	5,888
10-80	3,395	30-60	7,292	60-65	5,372
15-15	11,960	30-65	6,447	60-70	4,680
15-20	11,585	30-70	5,442	60-75	3,866
15-25	11,324	30-75	4,365	60-80	2,992
15-30	11,021	30-80	3,290	65-65	4,960
15-35	10,655	35-35	9,680	65-70	4,378
15-40	10,205	35-40	9,331	65-75	3,665
15-45	9,690	35-45	8,921	65-80	2,873
15-50	9,076	35-50	8,415	70-70	3,930
15-55	8,403	35-55	7,849	70-75	3,347
15-60	7,622	35-60	7,174	70-80	2,675
15-65	6,705	35-65	6,360	75-75	2,917
15-70	5,631	35-70	5,382	75-80	2,381
15-75	4,495	35-75	4,327	80-80	2,018
15-80	3,372	35-80	3,268	85-85	1,256
20-20	11,232	40-40	9,016	90-90	0,909

To find the value of any annuity during the continuance of a life of any given age, or during the joint continuance of two lives, it is only necessary to multiply the value in the table, against the given age, by the annuity; or to find the annuity equivalent to any certain sum, divide the sum by the value in the table against the given age.

Examples.—What is the difference in value between an annuity of 50*l.* during the life of a person aged 35, and an annuity of 60*l.* during two lives of 30 and 35, to cease when either of the two lives shall fail?

The value in Table III. against the age of 35 is 12,502, which multiplied by 50 gives 625.1*l.* the value in Table V. against the ages of 30 and 35 is 9.954, which multiplied by 60 gives 597.24*l.* the value of the former annuity therefore exceeds the latter by 27*l.* 17*s.* 2*d.*

What annuity, during his life, ought a person aged 45 to receive in lieu of an annuity of 20*l.* certain for the term of 18 years?

The value of an annuity certain for 18 years, is by Table II. 11.689587, which multiplied by 20 gives 233 7917*l.* this sum divided by 11.105, the value of an annuity during a life of 45, by Table III. gives the answer of 21*l.* 1*s.*

What annuity, during his life, ought a person aged 40 to receive for 500*l.*?

The value of an annuity during a life of 40 years of age, is by Table III. 11.837, and 500*l.* divided by this sum gives 42*l.* 4*s.* 9*d.* per annum; but if the value of the life is taken, as in Table IV. (or 13.466), the sum to be received will be 37*l.* 2*s.* 7*d.*

For the values of annuities which are not to commence till after a certain period, or after a given life or lives, see Reversions.

Annuities are frequently granted by parishes, trusts, and public societies, for the purpose of raising money for the erection or repair of churches, chapels, workhouses, bridges, or other expensive buildings; it being often found practicable to obtain money in this way, when it could not be procured at the ordinary rate of interest; it has likewise the recommendation of gradually extinguishing the debt, which might otherwise often remain a permanent burthen. Life annuities are also frequently granted, for money borrowed by persons possessing life estates, and who, therefore, can not give the lender a permanent security. As such annuities depend on the life of the grantor, few persons are disposed to purchase them, unless they can be obtained on such terms, as after allowing for the expense of assuring the grantor's life, leaves an income somewhat greater than the common rate of interest. It also frequently happens that the annuities are not very punctually paid, which with other risks attending them, causes annuities of this description always to sell considerably under their real value;

and in some instances the necessities of the borrowers have led them to make grants of this kind, on the most exorbitant terms. To throw, however, some check upon improvident transactions of this kind, which are usually carried on with great privacy, the statute 17 Geo. III. c. 26, usually called the Annuity Act, has directed that upon the sale of any life annuity of more than the value of 10*l.* (unless on a sufficient pledge of lands in fee simple, or stock in the public funds) the true consideration, which shall be in money only, and the names of the parties, shall be set forth and described in the security itself, in words at length; and a memorial of the date, the names of the parties, and of all the witnesses, and of the consideration money, shall within twenty days after its execution be enrolled in the Court of Chancery, else the security shall be null and void. All contracts for the purchase of annuities from persons under 21 years of age, are utterly void and incapable of confirmation, after the party becomes of age. Procuring or soliciting a minor to grant any life annuity, or to promise or engage to ratify it when he becomes of age, is an indictable misdemeanor, and punishable by fine and imprisonment; as is likewise the taking more than ten shillings per cent. for procuring money to be advanced for any life annuity. This act does not extend to annuities granted by any body corporate, or under any authority or trust created by act of parliament.

Notwithstanding these regulations, persons having occasion to raise money by the grant of life annuities, were obliged to submit to the most disadvantageous terms, as it seldom happened that individual purchasers would give for such annuities more than 8 years purchase, on lives about 30 years of age; or 7 years purchase on lives above 40; while on the other hand persons desirous of investing money in an annuity on their own life, were generally under the necessity of accepting private security, or of waiting till an opportunity offered of obtaining the security of some local toll or rates. To remedy these inconveniences an act was passed in 1793, authorising the Royal Exchange Assurance Company to grant and purchase annuities on lives, either immediate or in reversion: the rates according to which transactions of this kind are regulated necessarily vary in proportion to the current rate of interest at which money can be improved, a short specimen therefore of the present (1808) rates at which the Royal Exchange Assurance grant life annuities, will be sufficient.

Age.	per cent. per ann.			Age.	per cent. per ann.		
15.. ...	5*l.*	18*s.*	0*d.*	50.......	7*l.*	16*s.*	0*d.*
20......	6	0	0	55.......	8	6	0
25......	6	2	0	60.......	9	4	0
30......	6	6	0	65.......	10	4	0
35......	6	10	0	70.......	11	8	0
40......	6	16	0	75.......	12	18	0
45......	7	6	0	80.......	14	8	10

Several other societies, as the Globe Insurance, the Albion, the Rock, and the Eagle Insurance Companies, have lately granted life annuities, but it is presumed they vary their grants according to circumstances, as they none issue a printed table of their rates.

ANOMALIES, in music, are those false scales or intervals, which exist necessarily in all keyed instruments, from their incapacity of a true and perfect temperament.

ANOMALISTICAL *year*, in astronomy, the time that the earth takes to pass through her orbit: it is also called the periodical year. The space of time belonging to this year is greater than the tropical year, on account of the precession of the equinoxes.

ANOMALOUS *verbs*, in grammar, such as are not conjugated conformably to the paradigm of their conjugation: they are found in all languages; in Latin the verb *lego* is the paradigm of the third conjugation, and runs thus, *lego, legis, legit;* by the same rule it should be *fero, feris, ferit,* but we say *fero, fers, fert; fero* then is an anomalous verb. In English the irregularity relates often to the preter tense, and passive participle; for example, *give,* were it formed according to rule, would make *gived* in the preter tense, and passive participle; whereas, in the former, it makes *gave,* and in the latter *given.*

ANOMALY, in grammar, that quality in words which renders them anomalous. See the preceding article.

ANOMALY, in astronomy, an irregularity in the motion of the planets, whereby they deviate from the aphelion or apogee; which inequality is either mean, eccentric, or coequate and true.

ANOMIA, in natural history, a genus of worms of the order Testacea. Animal an emarginate ciliate strap-shaped body, with bristles affixed to the upper-valve; two arms, linear, longer than the body, connivent, projecting, alternate on the valve,

and ciliate each side, the fringe affixed to each valve; shell bivalve, inequivalve; one of the valves flattish, the other gibbous at the base with a produced beak, generally curved over the hinge; one of the valves often perforated near the base; hinge with a linear prominent cicatrix and a lateral tooth placed within, but in the flat valve on the very margin; two bony rays for the base of the animal. There are nearly fifty species enumerated by Gmelin, found in different parts of the world. A. ephippium has a shell, roundish, pellucid, with wrinkled plaits; the flat valve perforated. It inhabits European and American seas, and is frequently found sticking to the common oyster. About two inches long, $2\frac{1}{4}$ broad; the outside rugged and filmy, the inside smooth and pearly: varies in colour, but generally with a silvery hue.

ANONA, in botany, a genus of plants, belonging to the Polyandria Polygynia class of Linnæus. The perianthium is composed of three cordated, hollowed, and acuminated leaves; the corolla consists of six cordated sessile petals, three alternately interior and smaller; the stamina are scarce visible, but the antheræ are numerous; the fruit is a large berry, of an oval figure; covered with a squamose punctuated bark; the seeds are numerous, hard, of an oblong figure, and are placed circularly.

ANSERES, in natural history, the third order of birds according to the Linnæan system: they are distinguished by a smooth bill, covered with a soft skin and broader at the point; feet formed for swimming; toes palmate, connected by a membrane; shanks short and compressed; body fat and downy; flesh mostly tough; their food is fish, frogs, aquatic plants, worms, &c. They make their nest generally on the ground; the mother takes but little care in providing for the young. They are frequently polygamous. They are divided into those genera having bills with, and those without teeth: of the former are the

Anas,	Phaëton, and
Mergus,	Plotus.

Of the latter are the

Alca,	Pelecanus,
Aptenodytes,	Procellaria,
Colymbus,	Prynchops,
Diomedea,	and
Larus,	Sterna.

This order comprehends all kinds of water-fowl. The webbed feet of these birds are admirably adapted to aid them in swimming; and the greater quantity of oil secreted by the glands near the tail, and rubbed by means of their bills over all the feathers of their body, enables them to live on the water, without ever being wet. They live mostly on fish, and some of them have been occasionally tamed to the catching of fish for the use of their masters. In some of the lakes of China, where the water-fowl abound, the natives have the following ingenious mode of catching them: For several days before they attempt to take them, many empty gourd-shells are set afloat on the water, to habituate the birds to their appearance; and when they are observed to take no notice of these shells, but to swim among them, a man, with one of the same kind upon his head, goes into the lake, and wades or swims among the birds with nothing but his head above the water. He now begins his sport, and taking the birds by their legs, draws them under water, breaks their necks, and fastens them to his girdle, one after another, till he is sufficiently loaded, and then returns to the shore.

ANSWER, in law: On an indictment for perjury, in an answer in Chancery, it is a sufficient proof of identity, if the name subscribed be proved to be the hand-writing of the defendant; and that the same was subscribed by the master, on being sworn before him.

ANT. See FORMICA.

ANTECEDENCE, in astronomy, an apparent motion of a planet towards the west, or contrary to the order of the signs, *viz.* from Taurus towards Aries, &c.

ANTECEDENT, in grammar, the word to which a relative refers: thus, God whom we adore, the word God is the antecedent to the relative whom.

ANTECEDENT *term*, in mathematics, the first one of any ratio: thus, if the ratio be $a : b$, a is the antecedent term.

ANTEDATE, among lawyers, a spurious or false date, prior to the true date of a bond, bill, or the like.

ANTELOPE, in natural history, of the Mammalia class of animals, of the order Glires. The generic character is, horns hollow, seated on a bony core, growing upwards, annulated or wreathing, permanent. Front teeth in the lower jaw, eight, and no canine teeth. Antelopes constitute a very numerous race: they were formerly, even by Linnæus, ranged under the genus Capra, but now have obtained a rank for them-

selves: their habits and manners are thus described. They inhabit, two or three species excepted, the hottest parts of the globe; or, at least, those parts of the temperate zone that lie so near the tropics as to form a doubtful climate. None, therefore, except the Saiga and the Chamois, are to be met with in Europe; and notwithstanding the warmth of South America is suited to their nature, not a single species has yet been discovered in any part of the new world. Their proper climates seem, therefore, to be those of Asia and Africa, where the species are very numerous. "As there appears a general agreement in the nature of the species that form this great genus, it will prevent needless repetition to observe, that the antelopes are animals generally of a most elegant and active make; of a restless and timid disposition; extremely watchful, of great vivacity, remarkably swift and agile, and most of their boundings so light and elastic, as to strike the spectator with astonishment. What is very singular is, that they will stop in the midst of their course, gaze for a moment at their pursuers, and then resume their flight. As the chase of these animals is a favourite amusement with the eastern nations, from that may be collected proofs of the rapid speed of the antelope tribe. The greyhound, the fleetest of dogs, is usually unequal in the course, and the sportsman is obliged to call in the aid of the falcon, trained for the purpose, to seize on the animal, and impede its motions, in order to give the dogs an opportunity of overtaking it. In India and Persia a species of leopard is made use of in the chase: this is an animal that takes its prey not by swiftness of foot, but by the greatness of its springs, by motions similar to those of the antelope; but, should the leopard fail in its first essay, the game escapes. The fleetness of the antelope was proverbial in the country it inhabited, even in the earliest times: the speed of Asahel (2 Sam. ii. 18.) is beautifully compared to that of the Tzebi, and the Gadites were said to be as swift as the antelopes upon the mountains. The sacred writers took their similies from such objects as were before the eyes of the people to whom they addressed themselves. There is another instance drawn from the same subject: the disciple raised to life at Joppa was supposed to have been called Tabitha, *i. e.* Dorcas, or the antelope, from the beauty of her eyes; and to this day one of the highest compliments that can be paid to female beauty in the eastern regions, is *Aine el Czazel*, 'You have the eyes of an antelope'. Some species of antelopes form herds of two or three thousands, while others keep in troops of five or six. They generally reside in hilly countries, though some inhabit plains: they often brouse like the goat, and feed on the tender shoots of trees, which gives their flesh an excellent flavour. This is to be understood of those which are taken in the chase; for those which are fattened in houses are far less delicious. The flesh of some species is said to taste of musk, which perhaps depends on the qualities of the plants they feed upon." This preface (says Mr. Pennant) was thought necessary, to point out the difference in nature between this and the goat kind, with which most systematic writers have classed the antelopes: but the antelope forms an intermediate genus, a link between the goat and the deer; agreeing with the former in the texture of the horns, which have a core in them, and are never cast; and with the latter in elegance of form and swiftness.

The Common Antelope.—The Antelope, properly so called, abounds in Barbary, and in all the northern parts of Africa. It is somewhat less than the fallow-deer: its horns are about sixteen inches long, surrounded with prominent rings almost to the top, where they are twelve inches distant from point to point. The horns of the antelope are remarkable for a beautiful double flexion, which gives them the appearance of the lyre of the ancients. The colour of the hair on the back is brown, mixed with red; the belly and inside of the thighs white; and the tail short.

The Striped Antelope,—is a beautiful, tall gazelle, inhabiting the Cape of Good Hope; has long, slender shanks: its horns are smooth, twisted spirally, with a prominent edge or rib following the wreaths; they are three feet nine inches long, of a pale-brown colour, close at the base, and at the points round and sharp. The colour of this animal is a rusty brown; along the ridge of the back there is a white stripe mixed with brown; from this are eight or nine white stripes pointing downwards; the forehead and the fore part of the nose are brown; a white stripe runs from the corner of each eye, and meets just above the nose; upon each cheek-bone there are two small white spots; the inner edges of the ears are covered with white hair, and the upper part of the neck is adorned with a brown mane, an inch long; beneath the neck, from the

Fig. 1. Antelope *strepsiceros : striped antelope* *Fig. 2.* *A Oreas : Indian Antelope* *Fig. 3.* *White Antelope.*
Fig. 4. *A Gnu* *Fig. 5.* *Chevrotain* *Fig. 6.* *Memiana.*

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throat to the breast, are some long hairs hanging down; the breast and belly are grey; the tail is two feet long, brown above, white beneath, and black at the end.

The Gnu, the Hottentot name for a singular animal, which, with respect to its form, is between the horse and the ox.—It is about the size of a common galloway, the length of it being somewhat above five feet, and the height rather more than four. This animal is of a dark-brown colour; the tail and mane of a light grey; the shag on the chin and breast, and the stiff hairs which stand erect on the forehead and upper part of the face, are black; the curvature of the horns is singular; and the animal is represented in the figure in the attitude of butting, to give an idea of their form and position. The legs of the gnu are small; its hair is very fine; and it has a cavity beneath each eye, like most of the antelope kind.

The Chevrotain and Meminna.—The Chevrotain, or little Guinea Deer, is the smallest of all the antelope kind, the least of all cloven-footed quadrupeds, and we may add, the most beautiful. Its legs at the smallest part are not much thicker than a tobacco-pipe; it is not more than seven inches in height, and about twelve from the point of the nose to the insertion of the tail; its ears are broad; and its horns, which are straight, and scarcely two inches long, are black and shining as jet; the colour of the hair is a reddish brown; in some a beautiful yellow, very short and glossy. These elegant little creatures are natives of Senegal and the hottest parts of Africa; they are likewise found in India, and in many of the islands belonging to that vast continent. In Ceylon, there is an animal of this kind called Meminna, which is not larger than a hare, but perfectly resembling a fallow-deer. It is of a grey colour; the sides and haunches are spotted and barred with white; its ears are long and open; and its tail short. None of these small animals can subsist but in a warm climate. They are so extremely delicate, that it is with the utmost difficulty they can be brought alive into Europe, where they soon perish. They are gentle, familiar, most beautifully formed, and their agility is such, that they will bound over a wall twelve feet high. In Guinea, they are called Guevei. The female has no horns.

The Springer Antelope,—is an elegant species, weighs about fifty pounds, and is rather less than a roe-buck: inhabits the Cape of Good Hope; called there the Spring bock, from the prodigious leaps it takes on the sight of anybody. When alarmed, it has the power of expanding the white space about the tail into the form of a circle, which returns to its linear form when the animal is tranquil. They migrate annually from the interior parts in small herds, and continue in the neighbourhood of the Cape for two or three months; then join companies, and go off in troops consisting of many thousands, covering the great plains for several hours in their passage: are attended in their migrations by numbers of lions, hyænas, and other wild beasts, which make great destruction among them: are excellent eating, and, with other antelopes, are the venison of the Cape. Mr. Masson informs us, that they also make periodical migrations, in seven or eight years, in herds of many hundred thousands, from the north, as he supposes, from the interior parts of Terra de Natal. They are compelled to it by the excessive drought which happens in that region, when sometimes there does not fall a drop of rain for two or three years. These animals, in their course, desolate Caffraria, spreading over the whole country, and not leaving a blade of grass. Lions attend them: where one of those beasts of prey are, the place is known by the vast void visible in the midst of the timorous herd. On its approach to the Cape, it is observed that the avant guard is very fat, the centre less so, and the rear guard almost starved, being reduced to live on the roots of the plants devoured by those which went before; but on their return they become the avant guard, and thrive in their turn on the renewed vegetation; while the former, now changed into the rear guard, are famished, by being compelled to take up with the leavings of the others. These animals are quite fearless, when assembled in such mighty armies, nor can a man pass through unless he compels them to give way with a whip or stick. When taken young, they are easily domesticated: the males are very wanton, and are apt to butt at strangers with their horns. The expansile white part on the end of the back of this animal is a highly singular circumstance. It is formed by a duplicature of the skin in that part, the inside and edges being milk-white; when the animal is at rest, the edges alone appear, resembling a white stripe, but when alarmed, or in motion, the cavity, or white intermediate space, appears in form of a large oval patch of that colour.

The Scythian Antelope, or Saiga,—which is the only one of the species that is to be

found in Europe. The form of its body resembles the domestic goat, but its horns are those of an antelope, being marked by very prominent rings, with furrows between; they are a foot long, the ends smooth, of a pale-yellow colour, almost transparent. The male is covered with rough hair, like the he-goat, and has a strong scent; the female is smoother, hornless, and timid. The general colour is a dirty white. When they are attacked by wolves or dogs, the males stand round the females, forming a circle, with their heads towards the enemy, in which posture they defend their charge. Their common pace is a trot, when they go faster, it is by leaps; and are swifter than roe-bucks. When they feed, they are obliged to go backward, owing to the length of the upper lip, which they lift up. Their skin is soft, and excellent for gloves, belts, &c. They are found in flocks from six to ten thousand, on the banks of the Tanais and Boristhenes. The young are easily tamed, and will readily return to their master, when turned out on the desert.

The Nilgau, or White-footed Antelope,—is a large and beautiful species, known only within the space of a few years past. Its height is four feet one inch to the top of the shoulders, and its length, from the bottom of the neck to the base of the tail, four feet. The colour of the nilgau is a fine dark-grey or slate-colour, with a large spot of white beneath the throat, and two white bands or marks above each foot: the ears are large, white within, and edged with the same colour, and marked internally by two black stripes: along the top of the neck runs a slight mane of black hair, which is continued to some distance down the back, and on the breast is a much longer mane or hanging tuft of a similar colour: the tail is moderately long, and terminated by a tuft of black hair: the horns are short, pointed, smooth, triangular at their base, distant from each other, bent very slightly forwards, and of a blackish colour. The female resembles the male in general appearance, but is considerably smaller, of a pale brown colour, and is destitute of horns: the mane, pectoral tuft, and ears, resemble those of the male, and the feet are marked above the hoofs by three transverse bars of black and two of white. The nilgau is a native of the interior parts of India. According to Mr. Pennant, it abounded in the days of Aurengzebe between Delli and Lahor, on the way to Cashmire, and was called nylgau, or the blue or grey bull. It was one of the objects of the chace with that mighty monarch during his journey: they were inclosed by his army of hunters within nets, which being drawn closer and closer, at length formed a small precinct, into which the king and his omrahs and hunters entered, and killed the nilgaus with arrows, spears, and musquets; and that sometimes in such numbers, that Aurengzebe used to send quarters as presents to all his great people. The nilgau has of late years been often imported into Europe, and has bred in England. In confinement, it is generally pretty gentle, but is sometimes seized with fits of sudden caprice, when it will attack with great violence the objects of its displeasure. When the males fight, they drop on their knees at some distance from each other, and gradually advance in that attitude, and at length make a spring at each other with their heads bent low. This action, however, is not peculiar to the nilgau, but is observed in many others of the antelope tribe. The nilgau is said to go with young about nine months, and to produce sometimes two at a birth: the young is of the colour of a fawn.

Antelope Leucoryx, or White Antelope,—is entirely milk-white, except the markings on the face and limbs. It is an inhabitant of an island in the Gulf of Bassora. See Plate Mammalia, fig. 1—6.

ANTHEM, a church-song performed in cathedral service by choristers, who sing alternately. It was formerly used to denote both psalms and hymns, when sung in this manner. But at present, anthem is used in a more confined sense, being applied to certain passages taken out of the scriptures, and adapted to a particular solemnity.

ANTHEMIS, in botany, *chamomile*, a genus of the Syngenesia Superflua class and order. Receptacle chaffy; seeds generally crowned with a slight border; calyx hemispherical, nearly equal; florets of the ray more than five, oblong. There are two divisions of this genus, namely A. with a differently coloured or white ray; and B. ray the colour of the disk or yellow: there are about forty species.

ANTHERÆ, among botanists, denote the little roundish or oblong bodies, on the tops of the stamina of plants.

The anthera is the principal part of the male organ of generation in plants, answering to the glans penis in animals. It is tumid and hollow, containing a fine powder, called farina fœcundans.

ANTHERICUM, in botany, a genus of plants of the Hexandria Monogynia class and order. Cor. six-petalled, spreading, permanent; filaments uniform; capsule superior; seeds angular. There are three divisions. A. leaves channelled; filaments mostly beardless: B. leaves fleshy; filaments bearded: C. stamina dilated in the middle; root bulbous. There are between 50 and 60 species.

ANTHERYLIUM, a genus of the Icosandria Monogynia class and order. Calyx inferior, four-parted; petals four; capsule one-celled, three-valved, many-seeded. There is but a single species, a tree found at St. Thomas's Island.

ANTHISTERIA, in botany, a genus of the Polygamia Monoecia class and order. Hermaphrodite; florets sessile, male florets pedicelled; calyx four-valved, three or four-flowered, coriaceous: corol, glume two-valved, awnless; filaments three; styles two; stigmata clavate; seed one. There is but a single species.

ANTHOCEROS, a genus of the Cryptogamia Hepaticæ. Male; six parted or entire; antheræ three to eight, obovate, in the bottom of the calyx. Female; calyx sessile, cylindrical and entire. There are four species.

ANTHOLOMA, in botany, a genus of the Polyandria Monogynia class and order. Calyx two to four-leaved; cor. cup-shaped; many seeded. There is but a single species, a shrub found in Caledonia.

ANTHOLYZA, in botany, a genus of the Triandria Monogynia class and order. Corol. tubular, six-cleft, unequal, recurved; capsule inferior. There are six species, all found at the Cape.

ANTHOSPERMUM, in botany, the *amber tree*, a genus of plants belonging to the Tetrandia class and order. It is male and female, in different plants, and some are hermaphrodites. The androgynous flower is of one leaf, with two pistils and four stamina, with the germen below the flower. The male flowers are the same with these, wanting only the pistils and germen. The female flowers have the pistils and germen, but want the stamina. There are three species.

ANTHOXANTHUM, in botany, a genus of the Diandria Digynia class and order. Gen. char. calyx, glume two-valved, one-flowered; corol, glume two-valved, pointed, awned; seed one. There are four species.

ANTHREMIS, in natural history, a genus of insects of the order Coleoptera. Essen. char. antennæ clavate, the club solid; feelers unequal, filiform; jaws membranaceous, linear, bifid; lip entire; head hidden under the thorax. There are 13 species.

ANTHROPOMORPHA, in the Linnæan system of zoology, a class of animals, resembling in some degree the human form; the distinguishing characteristic of which is, that all the animals comprehended in it have four fore teeth in each jaw, and the teats are situated on the breast. Besides the human species, which stands at the head of this class, it likewise comprehends the monkey and sloath kinds.

ANTHYLLIS, the *bladder lotus*, in botany, a genus of the Diadelphia Decandria class of plants, the corolla whereof is papilionaceous; the fruit is a small roundish legume, composed of two valves, and containing one or two seeds. This genus is separated into the A. herbaceous and B. shrubby; there are of the former 12 species, of the latter nine.

ANTICHORUS, in botany, a genus of the Octandria Monogynia class and order. Calyx four-leaved; petals four; capsule superior, subulate, four-celled, four-valved; seeds numerous. There is only one species, found in Arabia.

ANTIDESMA, in botany, a genus of the Dioecia Pentandria class of plants, the calyx of which is a perianthium, consisting of five oblong concave leaves; there is no corolla; the fruit is a cylindric berry, containing one cell; in which is lodged a single seed. There are three species found in the East Indies and China.

ANTIMONY, in mineralogy, one of the metals that is brittle and easily fused. No metal has attracted so much of the attention of physicians as antimony. One party has extolled it as an infallible specific for every disease: while another decried it as a most virulent poison, which ought to be expunged from the list of medicines. Antimony, as it occurs under that name in the shops, is a natural compound of the metal with sulphur. To obtain it in a metallic state, the native sulphuret is to be mixed with two-thirds its weight of acidulous tartrite of potash, (in the state of crude tartar,) and one-third of nitrate of potash deprived of its water of crystallization. The mixture must be projected by spoonfuls, into a red-hot crucible; and the detonated mass poured into an iron mould greased with a little fat. The antimony, on account of

its specific gravity, will be found at the bottom adhering to the scoriæ, from which it may be separated by the hammer. Or three parts of the sulphuret may be fused in a covered crucible, with one of iron filings. The sulphur quits the antimony, and combines with the iron. Antimony in its metallic state (sometimes called regulus of antimony) is of a silvery white colour, very brittle, and of a plated or scaley texture. It is fused by a moderate heat; and crystallizes, on cooling, in the form of pyramids. In close vessels it may be volatilized, and collected unchanged. It undergoes little change when exposed to the atmosphere at its ordinary temperature; but when fused, with the access of air, it emits white fumes, consisting of an oxide of the metal. This oxide had formerly the name of flowers of antimony. Antimony combines with phosphorus and sulphur. With the latter, an artificial sulphuret is formed, exactly resembling the native compound, which last may be employed, on account of its cheapness, for exhibiting the properties of this combination of antimony. Antimony is dissolved by most of the acids. Sulphuric acid is decomposed; sulphurous acid being disengaged, and an oxide formed, of which a small proportion only is dissolved by the remaining acid. Nitric acid dissolves this metal with great vehemence; muriatic acid acts on it by long digestion; but the most convenient solvent is the nitro-muriatic acid, which, with the aid of heat, dissolves it from the native sulphuret. With oxygenized muriatic acid, it forms a compound of a thick consistence, formerly called butter of antimony. This may be formed, by exposing black sulphuret of antimony to the fumes of oxygenized muriatic acid, and subsequent distillation; or by distilling the powdered regulus with twice its weight of corrosive muriate of mercury. The metal becomes highly oxydized, and unites with muriatic acid in its simple state. On pouring this compound into water, a white oxide falls down, called powder of algaroth. Antimony is susceptible of various states of oxydizement. The first oxide may be obtained by washing algaroth powder with a little caustic potash. It is composed of $18\frac{1}{2}$ oxygen, and $81\frac{1}{2}$ metal. That formed by the action of nitric acid on antimony, contains 77 metal, and 23 oxygen. See ORES, *analysis of*.

ANTINOMIANS, in church history, a sect of Christians, who reject the moral law as a rule of conduct to believers, disown personal and progressive sanctification, and hold it to be inconsistent for a believer to pray for the forgiveness of sins. Although these principles will, by some, be thought to lead to mischievous consequences and practice, yet there are, unquestionably, worthy men and virtuous Christians, who avow Antinomian tenets. To the young, the giddy, and the thoughtless, such sentiments might, if acted upon, be the source of much evil; but these like the doctrine of necessity, are rarely believed but by persons who have already attained to virtuous habits.

ANTIPATHES, in natural history, a genus of worms of the order Zoophyta. Animal growing in the form of a plant: stem expanded at the base, internally horny, beset with small spines, externally covered with a gelatinous flesh, beset with numerous polype-bearing tubercles. There are 13 species. A. spiralis, inhabits the Indian, Mediterranean, and North seas; of a hard, horny, black, substance, exceedingly brittle, very long, and variously twisted, about the size of a writing pen. A. alopecuroides, with spinous setaceous closely panicled branches; inhabits South Carolina; about two feet high, and rises from a broad spread base, dividing into several large branches, flat on one side, with a groove along the middle; it then subdivides into smaller branches, forming close panicles, not unlike the fox-tail grass: the outside greyish, the inside black and very brittle.

ANTIPODES, in geography, a name given to those inhabitants of the globe that live diametrically opposite to one another. They lie under opposite parallels, and opposite meridians. They have the same elevation of their different poles. It is midnight with the one, when it is noon-day with the other; the longest day with one is the shortest with the other; and the length of the day with the one is equal to the night of the other. See GLOBES, *use of*.

ANTIQUARY, a person who studies and searches after monuments and remains of antiquity.

There were formerly, in the chief cities of Greece and Italy, persons of distinction called antiquaries, who made it their business to explain the ancient inscriptions, and give every other assistance in their power to strangers who were lovers of that kind of learning. Foundations of this kind have existed in England. Sir H. Spelman speaks of a society of antiquaries in his time, which had been instituted in 1572, by Archbishop

Parker, Camden, Sir Robert Cotton, Stowe, and others. Application was made in 1589 to Queen Elizabeth for a charter, and house in which they might hold their meetings, erect a library, &c. But the death of the sovereign put an end to the design. In 1717, this society was revived again, and has continued without interruption; and at present, it is in a very flourishing state, consisting of learned men in every rank of life. The society was incorporated in 1751 and began to publish an account of its discoveries in 1770, under the title of "Archæologia:" fifteen volumes in quarto are already published.

ANTIQUITIES, a term implying all testimonies, or authentic accounts, that have come down to us of ancient nations. According to Lord Bacon, antiquities may be considered as the wrecks of history, or such particulars as industrious and learned persons have collected from genealogies, inscriptions, monuments, coins, names, etymologies, archives, instruments, fragments of history, &c.: in this sense the study of antiquities leads us to inquire into the origin and early epochas of every nation and people, whether ancient or modern. Hence the study of antiquities, as a science, has become, in almost every civilized country, an interesting pursuit to men of leisure and curiosity. By many persons it has been sufficient to investigate the ancient remains of Greece and Rome; but others, who have taken a more enlarged, and, what we deem, a more proper view of the subject, include in the science the antiquities of the Jews, Egyptians, Phœnicians, Carthaginians, and, in short, all those principal nations mentioned in ancient history. Our view of the subject must necessarily be contracted, and the most we can aim at is, to excite a laudable curiosity in the young, and to direct them to objects that may engage their attention, and to the authors most likely to furnish information under the several heads of inquiry and research.

This study has for its chief objects the ceremonies, customs, and usages which obtained in ancient times, either with regard to persons, places, or things. Writers have accordingly divided antiquities into civil and ecclesiastical: including under the former head whatever relates to political, military, literary, and domestic concerns; and under the latter, the subjects connected with religion, as the worship, discipline, and faith of ancient times and people. Christians have usually separated their antiquities into those which relate to the ancient state of the Christian church; and into whatever belongs to the ancient laws, ceremonies, events, &c. that occur in the scriptures. These, indeed, form a branch of ecclesiastical antiquities, and bear a near relation to the Jewish antiquities, concerning which we have many respectable authorities. There are persons who would deduce most of the heathen antiquities from the manners and customs described in the Bible; while others, as Spencer, take the opposite course, and deduce the antiquities of the Bible from those of heathenism. Perhaps a middle course would be nearer the truth, as it is absolutely necessary, in interpreting scripture, to attend to the heathen antiquities alluded to in them; and these not only such as are directly aimed at or approved, but also such as are purposely opposed. National antiquities are those employed in tracing the origin, ancient actions, usages, monuments, remains, &c. of some nation or people: and it may be observed, that almost every nation lays claim to a greater degree of antiquity than the rest of its neighbours. The Scythians, the Phrygians, the Chaldeans, Egyptians, Greeks, Chinese, &c. pretend each to have the honour of being the first inhabitants of the earth: several of these nations, lest they should be surpassed in their pretensions by any of the rest, have traced up their origin to ages long before the received account of the creation. Hence the appellations "aborigines," "indigenæ," "terrægenæ," "antelunares," &c.

The history and antiquities of nations and societies have been objects of inquiry, inasmuch as they enable the mind to separate truth from falsehood, and tradition from evidence, to establish what had probability for its basis, or to explode what rested only on the vanity of the inventors and propagators: of this we have a striking instance in the Chaldeans, who pretend to astronomical observations of nearly 500,000 years. They mention the king who reigned over them at the time of the deluge, and attribute to him several things which we ascribe to Noah. The Chaldaic antiquities of Berosus are, however, lost, except a few fragments which have been collected by Joseph Scaliger, and Fabricius. To supply the chasm, Annius Viterbo, a Dominican monk, towards the close of the 15th century, forged the work of Berosus, which he published at Rome in 1498. He went farther, and produced a supplement to Be-

rosus, supposed to have been written by Manetho, containing details of what happened from the time of Ægyptus, king of Egypt, to the origin of the Roman state. Unfortunately for the credit of the industrious monk, Manetho lived before Berosus, by which the fraud was detected.

The first traces of every history were rude and imperfect, which renders the office of the antiquarian of the utmost importance to the faithful and diligent historian. Better methods of preserving facts succeeded. The unchisseled stone, or the rudest hieroglyphic, accompanied the songs of the bards to perpetuate the achievements of a whole nation, or a few individuals; till the use of letters, and the complicated transactions, claims, and interests of men taught them to multiply memorials, and draw them up with more skill and accuracy.

The history contained in the Old Testament is unquestionably the most ancient, well-authenticated collection of facts, that has come down to the present times. These records go much beyond the flood, the boundary to the annals of every other nation that lays a just claim to credit. The Jews, who are closely connected with this part of history, trace back their ancestry to the common parents of the human race. The antiquities of this wonderful nation have been treated of by numerous writers, whose works are monuments of great learning and indefatigable industry; and it will be admitted, that the fate of a people scattered over the globe, who have been subject to persecutions, more or less severe, for so many centuries; who have never amalgamated, if we may so speak, with any other nation under heaven, but have remained distinct, for wise and important ends, cannot but interest the curious inquirer. The history of their origin, ordinances, and vicissitudes, previously to the Christian æra, is to be had in the Old Testament: their subsequent ruin and dispersion are predicted by Christ in the New Testament, and treated of at large by Josephus, who flourished at Rome under Vespasian, Titus, and Domitian, and who published his great work on the Jewish Antiquities during the life and reign of the latter. On the same subject we have a multitude of more modern writers from Ugolinus' Thesaurus, consisting of more than thirty volumes folio, and comprising all the best works written previously to the middle of the last century, to the octavos Dr. Jennings evidently intended as a mere introduction to the subject. The antiquities of the Jews are supposed to be connected with those of Egypt, since Moses, their great lawgiver, was educated in the schools of Egyptian learning, and was deeply conversant in all their sciences. Many of the metaphors and other allusions found in the first five books of the Bible are supposed to have some reference to the symbols of the Egyptian priests. If we were, therefore, able to come at a faithful account of the antiquities of Egypt we might hope to attain an illustration of many things which are still obscure and dark belonging to the Jewish economy, both civil and sacred. Of Egypt, alas! once renowned for its laws, the commerce of her cities, the grandeur of her buildings, and the fertility of territory, little is left to gratify the laudable curiosity of moderns. Those who have spent much time and labour in appreciating the worth and merits of the ancients, admit that the earliest nations of the world were fed with the produce of Egyptian soil, and enriched with the wealth and wisdom obtained in that portion of Africa. Upper Egypt furnished the materials of marble and porphyry, with which the most stupendous works of art were reared: and to Hermes Trismegistus, or, as he is sometimes called, Thoth, are ascribed, among the Egyptians, the inventions of chief use in human life. Their priests maintained that from the hieroglyphic characters upon the pillars which he erected, and the sacred books, all the philosophy and learning of the world has been derived.

Egypt seems itself to have been indebted for its original population to the northern parts of Arabia and Syria, the Egyptians and Abyssinians having been always wholly distinct from the native nations of Africa. The Copts, or original inhabitants, it has been observed by travellers, have no resemblance whatever of the negro features or form; but a strong likeness may be traced between the make of the visage in the modern Copts, and that presented in the ancient mummies, paintings, and statues. Their complexion, like that of the Arabs, is of a dusky brown. It is represented of the same colour in the paintings which may be seen in the tombs of Thebes. The chief antiquities are the pyramids, and the tombs near Thebes, recently disclosed, with many ruins of temples, and other remains of ancient cities. Dr. White, in the "Egyptiaca," a work which contains much valuable in-

formation on the subject, says, the celebrated column ascribed to Pompey, ornamented a space opposite to the temple of Serapis, in which was a great public library. Besides the ancient remains already noticed, we may mention the colossal sphynx; Cleopatra's needle; the marble sarcophagus reputed to be Alexander's tomb; and the triple inscription from Rosetta, in the hieroglyphic, the vernacular Egyptian, and the Greek characters. The writers on Egyptian antiquities are very numerous. Among the ancients may be noted Herodotus, Pausanias, Strabo, Diodorus Siculus, and Plutarch. Herodotus, Thales, and Pythagoras, were initiated into all the mysteries of the Egyptian priests. The mythology of the country is fully explained in Joblonski's "Pantheon Egyptiacum." On the Egypt of modern times we have the works of Pocock, Niebuhr, Sonnini, and Denon, which may be consulted with advantage. Greaves and Nordon have written on the pyramids, and the mummies are described by the celebrated Kircher.

The illustration of the antiquities of India is more difficult, but discoveries are still making in that vast extent of country. To that great patriot, philosopher, and legislator, Sir William Jones, we are greatly indebted for much valuable information on this subject. Mr. Halhed, indeed, in 1776, gave the first specimen which appeared of the early wisdom of the Indians, and their extensive skill in jurisprudence. In the year 1785, the Bhagvat Geeta was edited by Mr. Wilkins. The theological and metaphysical doctrines of this work were represented to be of the profoundest kind, and it was said to contain all the grand mysteries of the Hindoo religion, and laid claim to the antiquity of 4,000 years. Other works of high reputation have succeeded, among these are the "Indian Antiquities," by Maurice, which have, in a great measure, cleared the ground for the student, and given him a sort of clue for farther investigations. By his labours, the ancient geographical divisions of India, according to the classical writers of Greece and Rome, and of Hindostan, according to the Hindoos themselves, are reconciled; the analogies of the Brahmanic with other systems of theology considered; and the grand code of civil laws, the original form of government, and the literature of Hindostan, are compared with the laws, government, and literature of Persia, Egypt, and Greece. From Sir William Jones's papers published in the several volumes of the "Asiatic Researches," much solid information on Indian antiquities may be had in a short compass. By that great man, whose loss cannot be sufficiently lamented, a society was formed for inquiring into the history, antiquities, arts, sciences, and literature of Asia. Having founded the institution, he gave it celebrity by his own admirable discourses; of these the first was on the orthography of Asiatic words in Roman letters, a want of attention to which had occasioned much confusion in history and geography. Not contented with pointing out radical defects, he proposed a system, which was useful to the learned, and essential to the progress of the student. His other dissertations, to which the reader may be referred, were all in a greater or less degree, connected with the antiquities of India. By India is meant the whole extent of country in which the primitive religion and language of the Hindoos prevail at this day, and in which the Nægari letters are still used with more or less deviation from their original form. Its inhabitants have no resemblance either in their figure or manners to any of the nations contiguous to them. Their sources of wealth are still abundant. In their manufactures of cotton they surpass the other nations of the world; and though now degenerate and abased, there remains enough to show, that in some early age they were well-versed in arts and arms, happy in government, wise in legislation, and eminent in various branches of knowledge.

In this place we may briefly notice the Sanscrit language, which, whatever may be its antiquity, is of a very singular structure; more perfect than the Greek, more copious than the Latin, and more refined than either, yet bearing to both a stronger affinity, both in the roots of verbs, and in the forms of grammar, than could possibly have been produced by accident. Of their philosophy it has been observed, that in the more retired scenes, in groves, and in seminaries of learning, we may perceive the Brahmans and the Sarmanas of Clemens disputing in the forms of logic, or discoursing on the vanity of human enjoyments, on the immortality of the soul, her emanation from the eternal mind, her debasement, wanderings, and final union with her source.

The ancient monuments of Hindostan are very numerous, and of various descriptions, exclusive of the tombs and other edifices of the Mahometan conquerors. Some of the most remarkable are excavated temples,

statues, relievos, &c. in an island near Bombay; but the most magnificent and extensive are near the town of Ellora, about two hundred miles east of Bombay. The latter are minutely described and illustrated with plates in the sixth volume of the Asiatic Researches. The idols represented seem clearly to belong to the present mythology of Hindostan; but at what period these edifices were modelled, whether three hundred or three thousand years ago, cannot be easily ascertained. Several ancient grants of land, some coins, and seals, have also been found, which, however, do not greatly correspond with the exaggerated ideas entertained concerning the early civilisation of this renowned country; while the Egyptian pyramids, temples, and obelisks, strongly confirm the accounts preserved by ancient historians. Though the mythology of the Hindoos may pretend to great antiquity, yet their present form of religion is supposed to vary considerably from the ancient. It is inferred that while the religion of Boodha, still retained by the Birmans and other adjacent nations, was the real ancient system of Hindostan, the religion of the Hindoos is artfully interwoven with the common offices of life; and the different casts are supposed to originate from Brahma, the immediate agent of creation under the Supreme Power.

The remains of architecture and sculpture seem to prove an early connection between India and Africa. Of the ancient arts and manufactures little is known, excepting the labours of the Indian loom and needle. The Hindoos are said to have boasted of three inventions, *viz.* the method of instruction by "apologues," "the decimal scale," and "the game of chess."

Of the antiquities of Greece and Rome much has been written that merits the attention of the student in literature: these are subjects in which every well educated youth is made conversant at an early period. They are taught in all our classical schools, as necessary to the elucidation of those works that are read in the attainment of the ancient languages. Potter on the Greek Antiquities, and Kennet and Adams on those of Roman, are familiar to every ear: in their kind they are truly respectable, though they may be regarded only as elementary treatises, calculated rather to excite a taste for the study, than to satisfy the inquirer in pursuit of knowledge.

The first accounts of Greece are derived from ages long before the common use of letters in the country, so that it is difficult to distinguish where fable concludes, and real history begins. From the Phœnician and Egyptian colonies the Greeks first received the culture of humanity. By the Phœnicians they were instructed in trade, navigation, and the use of letters; and by the Egyptians in civil wisdom, the politer sciences, and religious mysteries. The antiquities of such a country, which became in after ages so illustrious in the annals of mankind, cannot fail to have excited a considerable degree of interest in every age: they have accordingly been carefully and minutely investigated by writers celebrated alike for their erudition and industry. Of these we can enumerate but a small portion in comparison of the many that have treated on the subject. Bishop Potter, to whom we have already referred, Bos, and others, have drawn up systems or abridgments of the whole, or at least of whatever relates to the religion, the gods, the vows, and the temples of Greece: on the public weal and magistracy, Stephanus and Van Dale are well worthy of notice: on the laws and punishments of Greece, we have Meursius and Petit: on military concerns, Arrian and Ælian are well known: on their gymnastic art and exercises, Joubert and Faber may be mentioned: on the theatres and scenic exhibitions, Scaliger and the abbe Barthelemy have written: besides these, we have many writers on their entertainments, on their marriages, the education of their children, and their funeral ceremonies. The best relics which display the former splendor of the Grecian states, have been preserved by Stuart in his Athens: in the Ionian Antiquities, and in the Voyage Pittoresque de la Grèece. The finest specimens of its sculpture in this country, are to be found among the Townley marbles: and of its coinage in the cabinet of Dr. Hunter.

It may be worthy of notice, in connection with the antiquities of Greece, that the ancient monuments of European Turkey now exceed in number and importance those of any other country. The remains of ancient Athens, in particular, formerly the chosen seat of the arts, have attracted the attention of many travellers, and have accordingly been frequently described with accuracy and taste. The church dedicated to the Divine Wisdom, usually denominated in the page of history Sancta Sophia, is a venerable monument of antiquity, and has been preserved from the sixth century, when it was built by Justinian, to the present period. The

architecture is very inferior to that of the classical period, yet by those who have witnessed it, we are told the effect is grand and impressive, and the cupola is admired as a bold and skilful effort of the art, while the seeming weight is diminished by the lightness of the materials, being bricks formed of a particular clay that will float in the water. The interior is adorned with columns of various and very beautiful descriptions, *viz.* the Phrygian purple, the Spartan green, the red and white Canan, and many others. To this may be added, that the French have recently discovered the remains of an ancient sea-port belonging to Sparta, near a promontory, which projects from the south of the Morea, and we are informed that the antiquities of that part now styled Albania, still present an extensive field of research to the student in this department of science.

"Nothing" says Dr. Adams, in the preface to his Roman Antiquities, "has more engaged the attention of literary men than to trace from ancient monuments the institutions and laws, the religion, the manners and customs of the Romans, under the general name of Roman Antiquities. This branch of knowledge," continues he, "is not only curious in itself, but absolutely necessary for the understanding the classics, and for reading with advantage the history of that celebrated people. It is particularly necessary for such as prosecute the study of the civil law. Scarcely on any subject have more books been written, and many of them by persons of distinguished abilities." We may, as a guide to the student, enumerate the writers from whom Dr. Adams chiefly compiled his own work, as these will be the best authorities for those persons who would enter deeply into the study. To Manutius, Brissonius, and Middleton, he was indebted for his facts relating to the business of the senate: to Pignorius, on slaves: to Lidonius and Grucchius, Manutius, Huber, Gravina, Merula, Heineccius, for what relates to the assemblies of the people, the rights of citizens, the laws and judicial proceedings: with respect to the duties and privileges of magistrates, the art of war, the shows of the circus, and the feats of gladiators, he had recourse to Lipsius:—to Sheffer he applied for information on naval affairs, and carriages: to Kermannus, on funerals: to Arbuthnot, on coins: to Donatus, on the city: to Turnebus, Salmasius, Grævius, Gronovius, Montfaucon, Gesner, and others, upon different subjects scattered through his work. To these may be added one of the oldest authors on the subject. *viz.* Dionysius Halicarnasseus, who traced the origin of the Romans, with great fidelity, back to the remotest ages. His accounts are generally preferred to those of Livy, because they are more ample, and his facts are described with more particulars; and on the ceremonies, worship, sacrifices, manners, customs, discipline, policy, courts, laws, &c. he is perhaps the most authentic writer.

These, and other authors that might be cited, have chiefly confined their account to Rome, properly so called, we might digress, and notice the antiquities of those states, both in Europe and other parts of the globe, which were held under the dominion of the Roman power; but this would lead us into a very wide field: we shall, however, in the connection notice those belonging to Spain, which was 500 years under the Roman power.

Spain was originally peopled by the Africans and German Gauls: it then became the prey of the Carthaginians: to these succeeded the Romans. It was afterwards held successively in subjection by the Vandals, the Visigoths, and the Arabs or Moors.

Of the first of these epochs few remains exist, excepting some tumuli, and other rude monuments. Nor are there any certain relics of the Carthaginians in Spain but coins, which have been found in considerable numbers. The Roman antiquities are numerous, of which, however, we shall notice but few. The aqueduct at Segovia is a noble edifice, consisting of 159 arches, extending about 740 yards, and is rather more than 94 feet in height where it crosses the valley. Morviedo, the ancient Saguntum, and Tarragona, the ancient Tarraco, afford many curious remains of antiquity. The theatre is capable of receiving 10,000 people, and is hewn out of a solid rock, the labour of which was less than might at first be expected, as the Spanish rocks are generally calcareous, or of gypsum. The Visigoth kings have left few relics except their coins, which are struck in gold, a metal at that period unknown to the other European mints. Numerous and splendid are the monuments of the Moors in Spain. The mosque at Cordova is one of the chief; this surprizes travellers with the multitude of its columns, which are said to be 800. The Christian antiquities here, as in other places, are churches, castles, and monasteries.

The antiquities of Portugal consist also

chiefly of Roman monuments, with some Moorish remains. In the north is an extensive series of arches, formerly a Roman aqueduct. At Evora are well-preserved ruins of a temple of Diana, and an aqueduct ascribed to Quintus Sertorius, whose life was written by Plutarch. Among the antiquities of the middle ages may be noted the monastery of Batalha, in Estremadura, 60 miles north of Lisbon, which is allowed on all hands to be one of the noblest monuments of what is called the Gothic style of architecture.

From this sketch of the antiquities of other nations we turn to those of our own; considering them under three divisions, as belonging, 1st, to England; 2d, to Scotland; and 3d, to Ireland. English antiquities fall into the following divisions, *viz.* those belonging to the primitive Celtic inhabitants; those of the Belgic colonies; those of the Romans; those of the Saxons; reliques of the Danes; and, lastly, Norman monuments. Few of these remains are thought to throw much light upon the history of the country: but being interesting and curious in themselves, they may, in this article, which is intended as a guide to the study, be briefly noticed. A radical mistake, according to Mr. Pinkerton, in the study of English antiquities has arisen from the confusion of the Celtic and Belgic languages and monuments. The Druids have deservedly attracted much curiosity and research; but it would be erroneous to impute to them, as is usual, the whole of our earliest remains. Cæsar speaks of Druidism as a recent institution, and if that be the case, it is not improbable that it originated from the Phœnician factories, established in wooden fortresses, the usual practice of commercial nations when trading with savage or barbarous people. The tenets correspond with what little exists of Phœnician mythology, and the missionaries of that refined people might have some zeal in their diffusion. Ancient authors, who give us all our information concerning the Druids, minutely describe their religious rites, but are totally silent concerning any monuments of stone being used among them. On the contrary, they mention gloomy groves and spreading oaks as the only scenes of the Druidic ceremonies; nevertheless antiquaries have inferred that Stonehenge is a Druidic monument, though it be situated in an extensive plain, where not a vestige of wood appears, and where the very soil is reputed to be adverse to its vegetation. It would be a vain effort to attempt to discriminate the remains of the earliest inhabitants from those of the Druidic period, and if the opinion of the last-mentioned author is to be regarded as binding, there is no foundation for any sound or real knowledge on the subject. The following have been esteemed as the monuments of the Druids: — 1. Single stones erect. 2. Rock idols and pierced stones. 3. Rocking-stones, used as ordeals. 4. Sepulchres of two, three, or more stones. 5. Circular temples, or rather circles of erect stones. 6. Barrows, or tumuli. 7. Cromlechs, or heaps of stones. 8. Rock-basons, imagined to have been used in Druidic expiations. 9. Caves, used as places of retreat in time of war. But as most of these relics may also be found in Germany and Scandinavia, it is difficult to say whether they are Gothic or Celtic; and as the Germans had no Druids, we cannot with any degree of certainty bestow the name of Druidic upon such monuments. It is highly probable, that the earliest inhabitants, as is ever the practice in the infancy of society, made use of wood, not of stone, in their religious as well as in their domestic erections. If we survey the various savage regions of the globe, we shall seldom, if ever, perceive the use of stone; and it is certainly just to infer, that the savages of the west were not more skilful than those of the east, nor those of the old continents and islands than those of the new. But as many of these monuments are found in Germany, Scandinavia, and Iceland, and as the Icelandic writers in particular often indicate their origin and use, which are unknown in the Celtic records, there is every reason to attribute them to a more advanced stage of society, when the Belgic colonies introduced agriculture, and a little further progress in the rude arts of barbarism. The nature of this work will not admit a formal investigation of such topics, but a few remarks may be offered on Stonehenge, a stupendous monument of barbaric industry. Inigo Jones, in attempting to prove that it is Roman, only evinces that no talents can avail when science is wanting, and that antiquities require a severe and peculiar train of study. Doctor Stukely, a visionary writer, assigns Stonehenge to the Druids; while Dr. Charlton, perceiving that such monuments are found in Denmark, ascribed it to the Danes. If the latter had considered, that the Belgæ were a Gothic nation of similar language and institutions, he might with more justice have extended its antiquity. From the

Icelandic writers we learn, that such circles were called *domh-ringr,* that is literally doom-ring, or circle of judgment, being the solemn places where courts were held of all kinds and dignities, from the national council down to the baronial court, or that of a common proprietor of land, for adjusting disputes between his villani and slaves. The magnificence of Stonehenge loudly pronounces that it was the supreme court of the nation, equivalent to the Champs de Mars et de Mai of the Franks, where the king and chiefs assembled in the circle, and the men capable of arms in the open plain; nor is it improbable that the chiefs ascended the transverse stones, and declared their resolves to the surrounding crowd, who, in the description of Tacitus, dissented by loud murmurs, or applauded by clashing their shields. This idea receives confirmation from the circumstance that the Belgæ, peculiarly so called, as being the chief and ruling colony of that people, were seated in the surrounding province, and Sorbiodunum, now Old Sarum, was their capital city. Similar circles of stone, but far inferior in size, are found in many parts of Great Britain and Ireland, and several undoubtedly as late as the Danish inroads and usurpations, the practice being continued by that people at least till their conversion to Christianity, in the tenth and eleventh centuries. Some of the smallest, as we learn from the northern antiquaries, were merely places of family sepulture. At a later period, the circles of judgment, which had been polluted with human sacrifices and other Pagan rites, were abandoned, and the great courts were held on what were called moot-hills, or hills of meeting, many of which still exist in the British dominions and in the Netherlands. They commonly consist of a central eminence, on which sat the judge and his assistants; beneath was an elevated platform for the parties, their friends, and compurgators, who sometimes amounted to a hundred or more; and this platform was surrounded with a trench, to secure it from the access of the mere spectators. Of the other monuments of this period a more brief consideration must suffice. When a monarch or distinguished general was buried, a barrow or hillock was erected to preserve his name and memory to future ages; the size depending on the reputation of the person, which attracted a smaller or larger number of operators. Such monuments are very ancient, and even to this day denote the sepulchres of some of the heroes of the Trojan war. In later times, a large single stone erected was esteemed a sufficient memorial: such single stones also sometimes appear as monuments of remarkable battles, or merely as boundaries. The caves are familiar to most nations in an early state of society. The Belgic relics are followed by those of the Romans, which are mostly objects of mere curiosity, and rarely throw the smallest light on the page of history. Amphitheatres are said to be still visible at Silchester, in Hampshire, and some other places. The Roman castle at Richborough, the ancient Rutupiæ, in Kent, presents considerable remains of a massy wall cemented with surprising firmness. The Roman ruins in this country are commonly composed of stone or flint, with strata of flat bricks at considerable intervals. The Mosaic pavements, hypocausts, &c. are generally the remains of the villas of opulent Romans, scattered over the country. The greatest number of Roman inscriptions, altars, &c. has been found in the north, along the great frontier wall, which extended from the western sea to the estuary of Tyne. This vast wall is justly esteemed the most important remain of the Roman power in England, as that of Antonius is in Scotland. The extent was about 70 miles, and its construction, forts, &c. have been illustrated by the labour of several antiquaries. Numerous are the more minute relics of the Romans in England, as coins, gems, weapons, ornaments, and the like; among which, however, the silver dish belonging to the Duke of Northumberland deserves especial mention. One of the grand causes of the civilization introduced by that ruling people into the conquered states was the highways, which form, indeed, the first germ of national industry, and without which neither commerce nor society can make any considerable progress. Conscious of this truth, the Romans seem to have lent particular attention to the construction of roads in the distant provinces; and those of England, which may still be traced in various ramifications, present a lasting monument of the justice of their conceptions, the extent of their views, and the utility of their power. A grand trunk, as it may be called, passed from the south to the north, and another to the west, with branches in almost every direction that general convenience and expedition could require. What is called the Watling-street, led from Richborough, in Kent, the ancient Rutupiæ, N.W. through London to Chester. The Ermin-street passed from London to

Lincoln, thence to Carlisle, and into Scotland, the name being supposed to be corrupted from Herman, which means warrior, as the chief wars lay in the north. The Fosse Way is supposed to have led from Bath and the western regions, N. E. till it joined the Ermin-street. The last celebrated road was the Ikenild, or Ikneld, supposed to have extended from near Norwich, S. W. into Dorsetshire. The Saxon antiquities in England are chiefly edifices, sacred or secular; many churches remain, which were altogether, or for the most part, constructed in the Saxon period, and some are extant of the tenth, or perhaps the ninth century. The vaults erected by Grimbald, at Oxford, in the reign of Alfred, are justly esteemed curious relics of Saxon architecture. Mr. King has ably illustrated the remains of the Saxon castles. The oldest seem to consist of one solitary tower, square or hexagonal: one of the rudest specimens is Coningsburg Castle, in Yorkshire; but as that region was subject to the Danes till the middle of the tenth century, it is probably Danish. Among the smaller remains of Saxon art, may be mentioned the shrines for preserving relics, which some suppose to present the diminutive rudiments of what is styled the Gothic architecture; and the illuminated manuscripts, which often afford curious memorials of the state of manners and knowledge. The Danish power in England, though of considerable duration in the north, was in the south brief and transitory. The camps of that nation were circular, like those of the Belgæ and Saxons, while those of Roman armies are known by the square form: and it is believed, that the only distinct relics of the Danes are some castles to the north of the Humber, and a few stones with Runic inscriptions. The monuments styled Norman, rather to distinguish their epoch than from any information that Norman architects were employed, are reputed to commence after the conquest, and to extend to the fourteenth century, when what is called the rich Gothic began to appear, which in the sixteenth century was supplanted by the mixed, and this in its turn yielded to the Grecian. In general the Norman style far exceeds the Saxon in the size of the edifices, and the decoration of the parts. The churches become more extensive and lofty, and though the windows retain the circular arch, they are larger and more diversified; the circular doors are festooned with more freedom and elegance; and uncouth animals begin to yield to wreaths of leaves and flowers. The solitary keep, or tower, of the Saxon castle is surrounded with a double wall, inclosing courts and dwellings of large extent, defended by turrets and double ditches, with a separate watch-tower, called the Barbican. Among others, the cathedrals of Durham and Winchester may be mentioned as venerable monuments of Anglo-Norman architecture; and the castles are numerous and well known. What is called the Gothic, or pointed arch, is generally supposed to have first appeared in the thirteenth century, and in the next it became universal in religious edifices. The windows diffused to great breadth and loftiness, and divided into branching interstices, enriched with painted glass; the clustering pillars, of excessive height, spreading into various fret-work on the roof, constitute, with decorations of smaller note, what is called the rich Gothic style, visible in the chapel of King's college, at Cambridge, and many other grand specimens in this kingdom. The spire corresponds with the interior, and begins about the thirteenth century to rise boldly from the ancient tower, and diminish from the sight in a gradation of pinnacles and ornaments.

We now proceed to Scotland, the original population of which is supposed upon good authority to consist of Cimbri, from the Cimbric Chersonese. About two centuries before the Christian æra, the Cimbri seem to have been driven to the south of Scotland by the Caledonians or Picti, a Gothic colony from Norway. The Cimbri, a congenerous people with the Welch, continued to hold the country south of the two firths of Forth and Clyde; but from the former region they were soon expelled by the Picti, who, in this corner, became subject for a time to the Anglo-Saxon kings of Bernicia. On the west, the Cumraig kingdom of Strath Clyde continued till the tenth century, when it became subject to the kings of North Britain; who at the same time extended their authority, by the permission of the English monarchs, over the counties of Cumberland and Westmoreland, which abounding with hills and fortresses on the south and east, were little accessible to the English power; and while the Danes possessed the country to the north of Humber, could yield little revenue or support to the Anglo-Saxon monarchs. From the Picti originates the population of the Lowlands of Scotland; the Lowlanders having been in all ages a distinct people from those of the western Highlands, though

the Irish clergy endeavoured to render their language, which was the most smooth and cultivated of the two, the polite dialogue of the court and superior classes. About the year of Christ 258, the Dalriads of Bede, the Attacotti of the Roman writers, passed from Ireland to Argyleshire, and became the germ of the Scottish Highlanders, who speak the Irish or Celtic language, while the Lowlanders have always used the Scandinavian or Gothic. In reference to the antiquities of the country, Mr. Pinkerton divides the early history into seven distinct periods, *viz.* 1. The original population of Scotland by the Cimbri, and by the Picti. 2. The entrance of Agricola into Scotland, and the subsequent conflicts with the Romans, till the latter abandoned Britain. 3. The settlement of the Dalriads or Attacotti, in Argyleshire, about the year 258, and their repulsion to Ireland about the middle of the fifth century. 4. The commencement of what may be called a regular history of Scotland, from the reign of Drust, A. D. 414. 5. The return of the Dalriads, A. D. 503, and the subsequent events of Dalryadic story. 6. The introduction of Christianity among the Caledonians, in the reign of Brudi II, A. D. 565. 7. The union of the Picti and Attacotti, under Kenneth, A. D. 843, after which greater civilization began to take place, and the history becomes more authentic. The monuments of antiquity belonging to these epochs, may be considered in the following order. Of the first epoch, no monuments can exist, except those of the tumular kind; and it is impossible to ascertain the period of their formation. The remains of the Roman period in North Britain chiefly appear in the celebrated wall built in the reign of Antoninus Pius, between the firths of Forth and Clyde, in the ruins of which many curious inscriptions have been found. Another striking object of this epoch, was a small edifice vulgarly called Arthur's Oven, which seems rightly to have been regarded by some antiquaries, as a small temple dedicated to the god Terminus, probably after the erection of the wall of Antoninus, for we are not to conceive these walls were the absolute lines beyond which the Romans possessed no territory; while, on the contrary, in the pacific intervals, the garrisons along the wall may have claimed the forage of the exterior fields; and the stream of Carron, beyond which this chapel stood, may have been considered as a necessary supply of water. The remains of the wall and forts, and other Roman antiquities in Scotland, particularly their camps and stations, many of which are remarkably entire, are ably illustrated in a late publication of General Roy; but the ingenious author has perhaps too implicitly followed a common antiquarian error, in ascribing all these camps, stations, &c. to Agricola, while they may be more justly assigned to Lollius Urbicus, A. D. 140, or to the Emperor Severus, A. D. 207, especially indeed, to the latter, for the Emperor's appearance, in person, to conduct two campaigns, probably as far as Inverness, must have occasioned the erection of works more eminent and durable than usual, the soldiers being excited by the animating controul of a military monarch. Constantius Chlorus also, A. D. 306, made a long progress into Scotland, if we trust the panegyrists. Nay, in the reign of Domitian, Bolanus, as we learn from Statius the poet, erected several works in Britain, probably in the north; so that it is idle to impute these remains to any one author: but to a judicious eye, the claims of Lollius Urbicus, and of Severus, seem preferable. The most northerly Roman camp yet discovered, is that near the source of the River Ythan, Aberdeenshire; periphery about two English miles. A smaller station has also been observed at Old Meldrum, a few miles to the S. E. Roman roads have been traced a considerable way in the east of Scotland, as far as the county of Angus, affording some evidence of the existence of the province Vespasiana; but the chief remains are within the wall. A hypocaust was also discovered near Perth, and another near Musselburgh, so that there was probably some Roman station near the Scottish capital. The smaller remains of Roman antiquity found in Scotland, as coins, utensils, &c. are numerous. With the fourth epoch may be said to commence the Pikish monuments of antiquity. The tombs it would be difficult to discriminate from those of the first epoch; but as the Caledonian kings, when converted to Christianity, held their chief residence at Inverness, the singular hill in its vicinity, presenting the form of a boat reversed, may, perhaps, be a monument of regal sepulture. The places of judgment among the Gothic nations, or what are now styled Druidic temples, are numerous; and there is a remarkable one in the Isle of Lewis, where, probably, the monarchs resided in the most early times; but this, perhaps, rather belongs to the Norwegian settlement in the ninth century. Some of these

monuments are of small circuit, and such are sometimes found at no great distance from each other; as they were not only sometimes erected merely as temples to Odin, Thor, Freyga, and other Gothic deities, but every chief, or lord of a manor, having jurisdiction over many servants and slaves, such small courts became places of necessary awe. The houses seem to have been entirely of wood or turf; but in some spots singular excavations are found rudely lined with stone: these are called Weems, and it is likely that they were always adjacent to the wooden residence of some chief, and were intended as depositories of stores, &c. the roofs being too low for comfortable places of refuge. The stations and camps of the natives are distinguished by their round form, while those of the Romans belong to the square. Under the next epoch it would be difficult to discover any genuine remains of the Dalriads. The houses, and even the churches, were constructed in wattle-work; and the funeral monuments were cairns or heaps of stones. It is probable that Christianity did not immediately dissolve ancient prejudices, and that even the Atticottic kings were buried in this rude manner; for the genuine chronicles do not affirm that they were conveyed to Hyona, or Icolmkill; and the sepulchres there shewn of Irish and Norwegian kings must be equally fabulous. To the sixth epoch may probably belong a chapel or two, still remaining in Scotland, for Bede informs us that Nethan III. A. D. 715, obtained architects from Ceolfrid, abbot of Jarrow and Weremouth, to build a church in his dominions, probably at Abernethy; but the round tower there remaining seems of more recent origin. About the year 830, Ungust II. founded the church of St. Andrew; and the chapel called that of St. Regulus, (who seems unknown in the Roman calendar) may, perhaps, claim even this antiquity. It is probable that these sacred edifices in stone were soon followed by the erection of those rude round piles, without any cement, called Piks-houses: yet they may more properly belong to the seventh epoch, when the Danes may share in the honour of the erection, for such edifices have been traced in Scandinavia. They seem to have consisted of a vast hall, open to the sky in the centre, while the cavities in the wall present incommodious recesses for beds, &c. These buildings are remarkable, as displaying the first elements of the Gothic castle; and the castle of Coningsburg in Yorkshire forms an easy transition. The engraved obelisks found in Forres, and in other parts of Scotland, have been ascribed to the Danish ravagers, who had not time for such erections. They are, probably, monuments of signal events, raised by the king or chiefs; and as some are found in Scandinavia, as recent as the fifteenth century, it is probable that many of the Scottish obelisks are far more modern than is generally imagined.

We are next to consider the antiquities of Ireland. The original population of this country passed from Gaul, and was afterwards increased by their brethren the Guydil from England. About the time that the Belgæ seized on the south of England, it appears that kindred Gothic tribes passed to the south of Ireland. These are the Firbolg of the Irish traditions, and appear to have been the same people whom the Romans denominated Scoti, after they had emerged to their notice by not only extending their conquests to the north and east in Ireland, but had begun to make maritime excursions against the Roman provinces in Britain. But Ireland had been so much crowded with Celtic tribes, expelled from the continent and Britain, by the progress of the German Goths, that the Belgæ almost lost their native speech and distinct character; and from intermarriages, &c. became little distinguishable from the original population, except by superior ferocity, for which the Scoti, or those who affected a descent from the Gothic colonies, were remarkable: while the original Gael seem to have been an innocent and harmless people. The epochs in Ireland to which its antiquities are referrable are the following: 1. The first historical epoch of Ireland is its original population by the Celtic Gauls, and the subsequent colonization by the Belgæ. 2. The maritime excursions of the Scoti against the Roman provinces in Britain. 3. The conversion of Ireland to Christianity in the fifth century, which was followed by a singular effect; for while the mass of the people retained all the ferocity of savage manners, the monasteries produced many men of such piety and learning, that Scotia or Ireland became celebrated all over Christendom. 4. This lustre was diminished by the ravages of the Scandinavians, which began with the ninth century, and can hardly be said to have ceased when the English settlement commenced. The island had been split into numerous principalities, or kingdoms as they were styled; and though a chief monarch

was acknowledged, yet his power was seldom efficient, and the constant dissensions of so many small tribes, rendered the island an easy prey. 5. In the year 1170, Henry II. permitted Richard Strongbow, earl of Pembroke, to effect a settlement in Ireland, which laid the foundation of the English possessions in that country. There are however coins of Canute, king of England, struck at Dublin, perhaps in acknowledgment of his power, by the Danish settlers. After this period Ireland became, in some measure, a commercial country, and her history is to be looked for in that of England, with which it is interwoven. Upon a review of the more ancient of these historical epochs, and of the monuments which may be considered as belonging to each, it must be considered that the edifices having been constructed of wood till the eleventh or twelfth century, it cannot be expected that any remains of them should exist. Stone was chiefly employed in the construction of funeral erections of various kinds; nor are barrows wanting in Ireland, being hillocks of earth, thrown up in commemoration of the illustrious dead. Other monuments, commonly stiled Druidic, may also be found in Ireland; such as single stones erect, circular temples or rather places of judgment, and the like, which may more properly be ascribed to the Belgic colony. The conversion of Ireland to Christianity was followed by the erection of a vast number of churches and monasteries, the latter being computed to exceed one thousand in number; but all these edifices were originally small, and constructed of interwoven withs, or hewn wood; for St. Bernard, in the twelfth century, mentions a stone church as a singular novelty in Ireland. But the Scandinavian chiefs must before this period have introduced the use of stone into the castles, necessary for their own defence against a nation whom they oppressed; and sometimes even subterraneous retreats were deemed expedient, of which Ware and others have engraved specimens. To the Scandinavian period also belong what are called the Danes Raths, or circular intrenchments; and some chapels, such as those of Glendaloch, Portaferry, Killaloe, Saul Abbey, St. Doulach, and Cashel, if we may judge from the singularity of the ornaments, which however only afford vague conjecture. But of the round castles, called Duns in Scotland, and of the obelisks engraven with figures or ornaments, few or none exist in Ireland. Under the Scandinavians the Irish coinage first dawns. Of the eleventh and twelfth centuries many monuments, castellated or religious, may probably exist in Ireland. Brian Boro, king of Munster, having been declared sovereign of Ireland in the year 1002, he distinguished himself by his virtues and courage; and Dermid III. A. D. 1041—1073, was also an excellent and powerful prince. Under these monarchs and their successors, Terdelvac and Moriertac, the power of the Scandinavians was considerably weakened. The native chiefs had been taught the necessity of fortresses, and were generally devoutly attached to religion; it is therefore to be inferred, that many castles, churches, and monasteries now began to be partly constructed in stone, by architects invited from France and England; but perhaps the round towers were erected by native builders. Among smaller reliques of antiquity, the golden trinkets found in a bog near Cullen, in the south, deserve mention: as gold was found in Gaul, they are perhaps ornaments of the ancient chiefs, brought from that region.

It remains now to mention the names of some of those authors who have written on the antiquities of our own country. Tacitus was an eye-witness to the ceremonies of Druidism in England, as the Romans were in Wales. To him, to Cæsar already referred to, and to Dio Cassius, we refer, as the chief authorities in regard to British history. To these may be added Ælian, Diodorus Siculus, Strabo, and Pliny. Cluverius, Pezron, and Pelloutier are more modern, but respectable writers on the same subject. Of the structures erected by the Britons, Abury and Stonhenge may be deemed the principal. Relics of a smaller kind are continually discovered a few feet beneath the surface of the earth. On these Stukely and Rowland are the best authorities: the former has written a volume on Abury, a temple of the Druids, in which is a particular account of the first and patriarchal religion, and of the peopling of the British islands: besides his larger work, entitled "Itinerarium Curiosum," being an account of the antiquities, &c. observed in travels through Great Britain, published in 1724. For the history of the Britons under the Roman Government, Horsley's Brit. Rom. is a work that may be depended upon. With respect to the antiquities of the Saxons, the illuminated manuscripts are the best records of their manners in the different centuries, and the most interesting information respecting

them has been collected by Turner and Strutt. The best collection of Saxon coins is in the British Museum, and of manuscripts in the same place and in the Bodleian Library. Mr. King has treated of their military antiquities in his History of Castles; and independently of our works on topography which are numerous, and many of them of the first respectability, and which throw considerable light on the antiquities of the country, we may refer to Henry's History of England, where the subject is discussed systematically and in chronological order; and to the works of Camden, Strutt, and Gough, to which may be added the whole series of the Gentleman's Magazine, and Pinkerton's Geography, to which we have been indebted for a part of this article.

As the antiquities of the united kingdom are in some respects connected with those of the Danes and other northern nations, we may suggest to the reader what are the principal remains of those people, as a clue to his future inquiries.

The ancient monuments of Denmark and Norway are chiefly Runic, though it is far from certain at what period the use of Runic characters extended so far north. Circles of upright stones are common in all the Danish dominions, the islands, Norway and Iceland, in which latter country their origin is perfectly ascertained, as some were erected even in recent times of the Icelandic republic, being called *domh-ring*, or circles of judgment. Some also appear to have been the cemeteries of superior families. Monuments also occur of two upright stones with one across; and of the other forms supposed to be Druidic. The residences of the chiefs appear to have been generally constructed of wood; as there are very few ancient castles existing in Denmark or Norway.

Of Sweden the ancient monuments consist chiefly of judicial circles and other erections of unhewn stone, together with remains inscribed with Runic characters, none of which are imagined to have existed longer than the eleventh century.

In Russia, the ancient monuments are neither numerous nor afford much variety. There are to be met with the tombs of their pagan ancestors, containing weapons and ornaments. From the writings of Herodotus we learn that the Scythians regarded the cemeteries of their princes with singular veneration; the Sarmations or Slavons seem to have imbibed the same ideas. The catacombs of Kiow, it is believed, were formed in the pagan period, though they are now replete with marks of Christianity. They are labyrinths of considerable extent, dug, as it should seem, through a mass of hardened clay, but they do not appear to contain the bodies of the sovereigns. The idols of Pagan Russia are sometimes found cast in bronze; and Dr. Guthrie has given a good account of the Slavonic mythology, to whose "Dissertations sur les Antiquites de Russie," we refer the reader. We may however observe, that the pagan Russians worshipped one god, supposed to be author of thunder; another, that resembled the Pan of the ancients; others, answering to the Sun, Hercules, Mars, Venus, and Cupid. They had also goddesses corresponding with Ceres, Diana, and Pomona, and their nymphs of the woods and waters. They worshipped Znitch or Vesta in the form of fire, and venerated waters, the Bog being as highly regarded by the ancient Russians as the Ganges among the Indians: the Don and the Danube were also considered as holy streams; and there was a sacred lake, environed with a thick forest, in the isle of Rugen, which was adored by the Sclavonic tribes.

ANTIRRHINUM, *snapdragon*, *toadflax*, in botany, a genus of the Didynamia Angiosperma. Calyx five-parted; corol with a necteriferous prominence at its base, pointing downwards; the orifice closed and furnished with a cloven convex palate: capsule two-celled. This genus is separated into five divisions, *viz.* A. leaves angular; capsules many valved. B. leaves opposite; capsules many valved. C. leaves alternate; capsules many valved. D. corols without spur; capsules perforated with three pores. E. leaves pinnatifid. There are 12 species of the first division; nearly 40 of the second division; 11 of the third; 7 of the fourth; and 2 of the last.

ANTISTROPHE, in grammar, a figure by which two things mutually dependent on one another, are reciprocally converted. As the servant of the master, and the master of the servant.

Antistrophe, among lyric poets, that part of a song and dance in use among the ancients, which was performed before the altar, in returning from west to east, in opposition to strophe. See the articles Strophe and Ode.

ANTITHESIS, in rhetoric, a contrast drawn between two things, which thereby serve as shades to set off the opposite qualities of each other.

The poets, historians, and orators im-

prove their subject, and greatly heighten the pleasure of the reader, by the pleasing opposition of their characters and descriptions.

The beautiful antithesis of Cicero, in his second Cartilinarian, may serve for an example: "On the one side stands modesty, on the other impudence; on the one fidelity, on the other deceit; here piety, there sacrilege; here continency, there lust, &c." And Virgil, in his admirable description of Dido's despair, the night before her death, represents all the rest of the creation enjoying profound tranquillity, to render the disquietude of that miserable queen the more affecting.

ANTOECI, in geography, an appellation given to those inhabitants of the earth who live under the same meridian, but on different sides of the equator, and at equal distances from it.

These have noon, and midnight, and all hours at the same time, but contrary seasons of the year; that is, when it is spring with the one, it is autumn with the other; when summer with the one, winter with the other. And the days of the one are equal to the nights of the other, and *vice versa.*

ANTONOMASIA, in rhetoric, a figure by which the proper name of one thing is applied to several others; or, on the contrary, the name of several things to one. Thus we call a cruel person, a Nero; and we say the philosopher, to denote Aristotle.

ANTS, *acid of.* See FORMIC ACID.

ANVIL, an iron instrument on which smiths hammer or forge their work, and usually mounted on a firm wooden block. A forged anvil is reckoned better than one of cast work.

ANUS, in anatomy, the extremity of the intestinum rectum, or orifice of the fundament. See ANATOMY.

AORIST, among grammarians, a tense peculiar to the Greek language, comprehending all the tenses; or rather, expressing an action in an indeterminate manner, without any regard to past, present, or future.

AORTA, in anatomy, called also arteria magna, a large artery arising with a single trunk from the left ventricle of the heart above its valves, called semilunares, and serves to convey the mass of blood to all parts of the body.

After ascending a little upwards, its trunk is bent, in manner of an arch, and from this part it sends, in human subjects, usually three ascending branches. This is called the aorta ascendens.

The descendens is that part of the trunk which, after the arch-like inflection, descends through the thorax and the abdomen down to the os sacrum, and is usually larger in women than in men. The aorta hath four tunics, a nervous, a glandulous, a muscular, and a membranous one. See ANATOMY.

APACTIS, in botany, a genus of the Dodecandria Monagynia class and order. No calyx; petals four, crenate, unequal; germ superior; fruit. There is but a single species, *viz.* the Japonica, a tree found, as its name imports, in Japan.

APALUS, in natural history, a genus of insects of the order Coleoptera. Gen. char. antennæ filiform; feelers equal, filiform; jaw horny, one-toothed; lip membranaceous, truncate, entire. There are two species, maculatus and the bimaculatus.

APARGIA, in botany, a genus of the Syngenesia Æqualis class and order. Receptacle naked; calyx imbricate; down feathery, sessile. There are 17 species.

APATITE, in mineralogy, one of the species of the Phosphates, occurs in tin veins, and is found in Cornwall and Germany. Colours white, green, blue, and red, of various shades. The primitive form of its crystals is a regular six-sided prism. Specific gravity between 2.8 and 3.2. When laid on ignited coals it emits a green light, and is almost entirely soluble in nitric acid. By rubbing it shews signs of electricity. It was formerly considered as a species of schorl, afterwards, on account of its colour and crystallization, it was arranged with beryll; others described it as fluor, but Werner soon found that it was a new species. Its fallacious resemblance to other minerals induced Werner to give it this name, which is derived from ἀπατάω, "to deceive."

APE. See SIMIA.

APETALOSE, or APETALOUS, among botanists, an appellation given to such plants as have no flower leaves.

APEX, in antiquity, the crest of a helmet, but more especially a kind of cap worn by the flamens.

APHÆRESIS, in grammar, a figure by which a letter or syllable is cut off from the beginning of a word.

APHÆRESIS, that part of surgery which teaches to take away superfluities.

APHELIUM, or APHELION, in astronomy, is that point in any planet's orbit, in which it is farthest distant from the sun; being in the new astronomy, that end of the

greater axis of the elliptical orbit of the planet, most remote from the focus wherein the sun is. The times of the aphelia of the primary planets may be known by their apparent diameters appearing least; as also, by their moving slowest in a given time. They may likewise be found by calculation, the method of doing which is delivered in most astronomical writers.

Sir Isaac Newton and Dr. Gregory have proved that the aphelia of the primary planets are at rest. See Princip. prop. 14. lib. 3. And in the scholium to the above proposition they say, that the planets nearest to the sun, *viz.* Mercury, Venus, the Earth, and Mars, from the actions of Jupiter and Saturn upon them, move a small matter in consequentia with regard to the fixed stars, and that in the sesquiplicate ratio of their respective distances from the sun.

APHIS, in entomology, a genus of the Hemiptera order, which has engaged the attention of naturalists for various reasons: their generation is equivocal, and their instinctive economy differs, in some respects, from that of most other animals. Linnæus defines the generic character of the aphis thus; beak inflected, sheath of five articulations, with a single bristle; antennæ setaceous, and longer than the thorax; either four erect wings, or none; feet formed for walking; posterior part of the abdomen usually furnished with two little horns. Geoffroy says, the aphides have two beaks, one of which is seated in the breast, the other in the head; this last extends to, and is laid upon the base of the pectoral one, and serves, as that writer imagines, to convey to the head a part of that nourishment which the insect takes, or sucks in, by means of the pectoral beak. Gmelin enumerates about 70 species, all of which, and doubtless many others, are found in different parts of Europe. They infest an endless variety of plants; and it is believed each species is particularly attached to one kind of vegetable only; hence each sort has been hitherto uniformly named after the individual species or genus of plants on which it feeds; or if that could not be ascertained, that on which it had been found; for some species are rather uncommon and little known, though others are infinitely too numerous. The aphides are sufficiently known by the indiscrimate term of plant-lice; they abound with a sweet and grateful moisture, and are therefore eagerly devoured by ants, the larva of coccinellæ, and many other creatures, or they would become, very probably, more destructive to the whole vegetable creation than any other race of insects known. If Bonnet was not the first naturalist (as is generally acknowledged) who discovered the mysterious course of generation in the aphides, or, as he calls them, pucerons, his experiments, together with those of his countryman, Trembly, tended at least to confirm, in a most satisfactory manner, the almost incredible circumstances respecting it, that an aphis or puceron, brought up in the most perfect solitude from the moment of its birth, in a few days will be found in the midst of a numerous family; and that if the experiment be again repeated on one of the individuals of this family, a second generation will multiply like its parent; and the like experiment may be many times repeated with the same effect.

The history of aphides has also been very copiously treated upon by Dr. Richardson, in a paper printed in the 41st vol. of the Philosophical Transactions; and by the late ingenious Mr. Curtis, in the sixth volume of the Transactions of the Linnæan Society. The tenor of Dr. Richardson's remarks is briefly this: the great variety of species which occur in the insects now under consideration may make an inquiry into their particular natures seem not a little perplexing, but by reducing them under their proper genus, the difficulty is considerably diminished. We may reasonably suppose all the insects, comprehended under any distinct genus, to partake of one general nature; and by diligently examining any particular species, may thence gain some insight into the nature of all the rest. With this view, Dr. Richardson chose out of the various sorts of aphides the largest of those found on the rose-tree; not only as its size makes it more conspicuous, but there are few of so long duration. This sort appears early in the spring, and continues late in autumn, while several are limited to a much shorter term, in conformity to the different trees and plants whence they draw their nourishment. If, at the beginning of February, the weather happens to be so warm as to make the buds of the rose-tree swell and appear green, small aphides are frequently to be found on them, though not larger than the young ones in summer when first produced. It will be found, that those aphides which appear only in spring, proceed from small black oval eggs,

which were deposited on the last year's shoot; though when it happens that the insects make too early an appearance, the greater part suffer from the sharp weather that usually succeeds, by which means the rose-trees are some years in a manner freed from them. The same kind of animal is then at one time of the year viviparous, and at another oviparous. These aphides which withstand the severity of the weather, seldom come to their full growth before the month of April, at which time they usually begin to breed, after twice casting off their exuvia, or outward covering. It appears that they are all females, which produce each of them a numerous progeny, and that without having intercourse with any male insect: they are viviparous, and, what is equally singular, they all come into the world backwards. When they first come from the parent, they are inveloped in a thin membrane, having in this situation the appearance of an oval egg; these egg-like appearances adhere by one extremity to the mother, while the young ones contained in them extend to the other, and by that means gradually draw the ruptured membrane over the head and body to the hind feet. During this operation, and for some time after, the fore part of the head adheres, by means of something that is glutinous, to the vent of the parent. Being thus suspended in the air, it soon frees itself from the membrane in which it was confined; and after its limbs are a little strengthened, is set down on some tender shoots, and is left to provide for itself. In the spring months, there appear on the rose-trees but two generations of aphides, including those which proceed immediately from the last year's eggs; the warmth of the summer adds so much to their fertility, that no less than five generations succeed one another in the interval. One is produced in May, which casts off its covering; while the months of June and July each supply two more, which cast off their coverings three or four times, according to the different warmth of the season. This frequent change of their outward coat is the more extraordinary, because it is repeated more often when the insects come the soonest to their growth, which sometimes happens in ten days, when they have had plenty of warmth and nourishment. Early in the month of June, some of the third generation, which were produced about the middle of May, after casting off the last covering, discover four erect wings, much longer than their bodies; and the same is observable in all the succeeding generations which are produced during the summer months, but still without any diversity of sex: for some time before the aphides come to their full growth, it is easy to distinguish which will have wings, by a remarkable fullness of the breast, which in the others is hardly to be distinguished from the body. When the last covering is rejected, the wings which were before folded up in a very narrow compass, are gradually extended in a surprising manner, till their dimensions are at last very considerable. The increase of these insects in the summer-time is so very great, that by wounding and exhausting the tender shoots, they would frequently suppress all vegetation, had they not many enemies to restrain them. Notwithstanding these insects have a numerous tribe of enemies, they are not without their friends, if those may be considered as such who are officious in their attendance for the good things they expect to reap thereby. The ant and bee are of this kind, collecting the honey in which the aphides abound, but with this difference, that the ants are constant visitors, the bee only when flowers are scarce; the ants will suck in the honey, while the aphides are in the act of discharging it; the bees only collect it from the leaves on which it has fallen. In the autumn three more generations of aphides are produced, two of which generally make their appearance in the month of August, and the third before the middle of September. The two first differ in no respect from those which are found in summer, but the third differs greatly from all the rest. Though all the aphides which have hitherto appeared were female, in this generation several male insects are found, but not by any means so numerous as the females. The females have, at first, the same appearance as those of the former generations, but, in a few days, their colour changes from a green to a yellow, which is gradually converted into an orange before they come to their full growth; they differ, also, in another respect, from those which occur in summer, for all these yellow females are without wings. The male insects are, however, still more remarkable, their outward appearance readily distinguishing them from this and all other generations. When first produced they are not of a green colour like the rest, but of a reddish brown, and have afterwards a dark line along the back: they come to their full growth in about

three weeks, and then cast off their last covering, the whole insect being, after this, of a bright yellow colour, the wings only excepted; but after this change they become of a deeper yellow, and in a very few hours, of a dark brown, if we except the body,* which is something lighter coloured, and has a reddish cast. The males no sooner come to maturity than they copulate with the females, who, in a day or two after their intercourse with the males, lay their eggs, generally near the buds. Where there are a number crowded together, they, of course, interfere with each other, in which case they will frequently deposit their eggs on other parts of the branches.—It is highly probable that the aphides derive considerable advantages by living in society; the reiterated punctures of a great number of them may attract a larger quantity of nutricious juices to that part of the tree or plant where they have taken up their abode. The observations of Mr. Curtis on the aphides are chiefly intended to shew that they are the principal cause of blights in plants, and the sole cause of the honey-dew. He therefore calls them the aphis, or blighter; and after observing, that, in point of numbers, the individuals of the several species composing it surpass those of any other genus in the country, speaks thus, in general terms, of the whole tribe. These insects live entirely on vegetables. The loftiest tree is no less liable to their attacks than the most humble plant. They prefer the young shoots on account of their tenderness, and on this principle, often insinuate themselves into the very heart of the plant, and do irreparable mischief before they are discovered. But, for the most part, they beset the foliage, and are always found on the underside of the leaf, which they prefer, not only on account of its being the most tender, but as it affords them protection from the weather, and various injuries to which they would otherwise be exposed. Sometimes the root is the object of their choice, which, from the nature of these insects one would not, *à priori,* expect; yet I have seen the roots of lettuces thickly beset with them, and the whole crop rendered sickly and of little value; but such instances are rare. They seldom attach themselves to the bark of trees, like the aphis salicis, which being one of our largest species, and hence possessing superior strength, is enabled to penetrate a substance harder than the leaves themselves. In the quality of the excrement voided by these insects, there is something wonderfully extraordinary. Were a person accidentally to take up a book, in which it is gravely asserted, that in some countries there were certain animals which voided liquid sugar, he would lay it down, regarding it as a fabulous tale, calculated to impose on the credulity of the ignorant; and yet such is literally the truth. Mr. Curtis collected some on a piece of writing-paper, from a brood of the aphis salicis, and found it to be sweet as sugar; and observes, that were it not for the wasps, ants, flies, and other insects that devour it as quickly as it is produced, it might, no doubt, be collected in considerable quantities, and by the processes used with other saccharine juices, might be converted into the choicest sugar or sugar-candy. The sweetness of this excrementitious substance, the glossy appearance it gave the leaves it fell upon, and the swarms of insects this matter attracts, led him to imagine the honey-dew of plants was no other than this secretion, which further observation has since fully confirmed; and not, as its name implies, a sweet substance falling from the atmosphere. On this opinion it is further remarked, that it neither falls from the atmosphere, nor issues from the plant itself, as is easily demonstrated. If it fell from the atmosphere, it would cover every thing it fell upon indiscriminately, whereas we never find it but on certain living plants and trees. We find it also on plants in stoves and green-houses covered with glass. If it exuded from the plant, it would appear on all the leaves generally and uniformly; whereas its appearance is extremely irregular, not alike on any two leaves of the same tree or plant, some having none of it, and others being covered with it but partially. It is probable that there never exists any honey-dew but where there are aphides; though such often pass unnoticed, being hidden on the underside of the leaf: and wherever honey-dew is observable upon a leaf, aphides will be found on the underside of the leaf or leaves immediately above it, and under no other circumstance whatever. If by accident any thing should intervene between the aphides and the leaf next beneath them, there will be no honey-dew on that leaf: and thus he conceives it is incontrovertibly proved that aphides are the true and only source of honey-dew. Of the British species of aphides, one of the largest and most remarkable is the aphis salicis,

which is found on the different kinds of willows. When bruised, these insects stain the fingers with red. Towards the end of September multitudes of the full-grown insects of this species, both with and without wings, desert the willows on which they feed, and ramble over every neighbouring object in such numbers that we can handle nothing in their vicinity without crushing some of them, while those in a younger, or less advanced state, still remain in large masses upon the trees. Aphis rosæ is very frequent, during the summer months, on the young shoots and buds of roses: it is of a bright green colour: the males are furnished with large transparent wings. A. vitis is most destructive to vines; as A. ulmi is to the elm-tree. Plate I. Entomology, fig. 3.

It is found, that where the saccharine substance has dropped from aphides for a length of time, as from the aphis salicis in particular, it gives to the surface of the bark, foliage, &c. that sooty kind of appearance which arises from the explosion of gunpowder: it looks like, and is sometimes taken for, a kind of black mildew. In most seasons the natural enemies of the aphides are sufficient to keep them in check, and to prevent them from doing essential injury to plants in the open air: but there are times, once perhaps in four, five, or six years, in which they are multiplied to such an excess that the usual means of diminution fail in preventing them from doing irreparable injury to certain crops.

To prevent the calamities which would infallibly result from an accumulated multiplication of the more prolific animals, it has been ordained by the Author of nature, that such should be diminished by serving as food for others. On this principle, most animals of this kind have one or more natural enemies. The helpless aphis, which is the scourge of the vegetable kingdom, has to contend with many: of these, the principal are, the coccinella; the ichneumon aphidum, and the musca aphidevora. The greatest destroyer of the aphides is the coccinella, or common lady-bird. During the winter this insect secures itself under the bark of trees and elsewhere. When the spring expands the foliage of plants, the female deposits its eggs on them in great numbers, from whence, in a short time, proceeds the larva, a small grub, of a dark lead-colour spotted with orange. These may be observed in the summer season running pretty briskly over all kinds of plants, and if narrowly watched, they will be found to devour the aphides wherever they find them. The same may be observed of the lady-bird in its perfect state. Another most formidable enemy to the aphis is a very minute, black, and slender ichneumon fly, which eats its way out of the aphis, leaving the dry inflated skin of the insect adhering to the leaf like a small pearl: such may always be found where aphides are in plenty. Different species of aphides are infested with different ichneumons. There is scarcely a division of nature, in which the musca or fly is not found: of these, one division, the aphidivora, feeds entirely on aphides Of the different species of aphidivorous flies, which are numerous, having mostly bodies variegated with transverse stripes, their females may be seen hovering over plants infested with aphides, among which they deposit their eggs on the surface of the leaf. The larva, or maggot, produced from such eggs, feeds, as soon as hatched, on the younger kinds of aphis, and as it increases in size, attacks and devours those which are larger. The larva of the hemerobius feeds also on the aphides, and deposits its eggs on the leaves of such plants as are beset with them. The earwig is likewise an enemy to them, especially such as reside in the curled leaves of fruit-trees, and the purses formed by certain aphides on the poplars and other trees. To these may be added the smaller soft-billed birds that feed on insects.

APHORISM, a maxim or principle of a science; or a sentence which comprehends a great deal in a few words. The term is seldom used but in medicine and law. We say, the aphorisms of Hippocrates, the aphorisms of the civil law, political aphorisms, &c.

APHRODITA, in natural history, a genus of worms, of the order Mollusca. Body creeping, oblong, covered with scales, and furnished with numerous bristly fasciculate feet on each side; mouth terminal, cylindrical, retractile; feelers two, setaceous, annulate; and four eyes. There are nine species. A. aculeata has an oval body, brown, beneath flesh colour, with long silky changeable hair on each side the body: it inhabits the European seas, is found in the belly of the cod-fish, and feeds on testaceous animals; is from four to seven inches long.

APHYLLANTHES, the *blue Montpelier pink*, in botany, a genus of the Hexandria Monogynia class of plants, the calyx of which is composed of a number of imbri-

cated, lanceolated spathæ; the corolla consists of six petals, of an obversely oval figure, terminating at the base in very narrow ungues, and patent at the limb, forming a kind of tube below it: the fruit is a turbinated capsule of a triangular figure, and contains three cells; the seeds are oval. There is but a single species.

APHYTEIA, in botany, a genus of the Monadelphia Triandria. Calyx large, funnel-form, three cleft; three petals inserted into and shorter than the calyx; germ inferior; berry one-celled, many-seeded; seeds imbedded.

APIAN, (PETER), in biography, an eminent astronomer and mathematician, called in German *Bienewitz*, was born at Loisnich, in Misnia, and became professor of mathematics at Ingoldstadt, in 1524. He wrote several treatises on astronomy and the mathematics, and enriched these sciences with many instruments and observations. His first work was a "Treatise on Cosmography, or Geographical Instructor:" this was published in 1530, and in three years after he constructed at Nuremberg a curious instrument, which shewed the hour of the day by means of the sun's rays, in all parts of the earth. In the year 1540, he published his principal work entitled "Astronomicon Cæsaræum," containing many interesting observations, with the descriptions and divisions of instruments, calculations of eclipses, and the construction of them in plano. In a second part of the work is a description of the construction and use of an astronomical quadrant, to which is annexed observations on five different comets: in these he shews that the tails of comets are always projected in a direction opposite to the sun. Our limits do not allow us to enumerate all the treatises of Apian: they were as respectable as numerous, and the author was treated with the kindest attention by the emperor Charles V., who published several of his works at his own expense, conferred upon him the honour of nobility, and presented him with 3000 crowns. Apian died at Ingolstadt in 1552, leaving behind him a high reputation for learning, and a son Philip, who was also an eminent astronomer, and taught the sciences both at Tubingen and Ingolstadt. Philip died in 1589, and left a treatise on "Solar-dials." He gave an account of the new star that appeared in Cassiopeia in 1572, which is preserved.

APIARY, a garden or other convenient place where bees are kept. A southern aspect is reckoned the most proper, and the bee-hives should be exposed as little as possible to the wind, and should enjoy as much of the influence of the sun as possible, as wind retards the bees in their work, while the beams of the sun invite them to it. In the vicinity of the apiary there should be plenty of flowers, wild thyme, and the like. The hives should be free from the droppings of trees, the annoyance of dunghills, long grass and weeds; as from these, insects are bred, which are not only destructive to bees, but greatly retard them in the preparation of honey. See APIS.

APIS, in natural history, a genus of insects of the order of Neuroptera. Gen. char. mouth furnished with jaws, and an inflected proboscis, with two bivalve sheaths; wings flat or without plaits; sting in the female and neutral insects concealed.

This genus is distributed by Linnæus into two assortments, *viz.* those in which the body of the animal is but slightly covered with fine hair or down, and those in which it is remarkably villose or hairy: the insects of the latter division are commonly distinguished by the title of humble-bees. In the first division, the principal or most important species is the apis mellifica, or common honey-bee, so long and justly celebrated for its wonderful polity, the neatness and precision with which it constructs its cells, and the diligence with which it provides, during the warmth of summer, a supply of food for the support of the hive during the rigours of the succeeding winter. The general history of this interesting insect has been amply detailed by various authors, as Swammerdam, Reaumur, &c. &c. Among the most elaborate accounts of later times, may be mentioned that of Mr. John Hunter, which made its appearance in the Philosophical Transactions for the year 1792, of which the following is an abstract. There are three periods at which the history of the bee may commence: first, in the spring, when the queen begins to lay her eggs; in the summer, at the commencement of a new colony; or in the autumn, when they go into winter quarters. We shall begin the particular history of the bee with the new colony, when nothing is formed. When a hive sends off a colony, it is commonly in the month of June; but that will vary according to the season, for in a mild spring bees sometimes swarm in the middle of May, and very often at the latter end of it. Before they come off, they commonly hang about the mouth of the hole or door of the hive, for some days, as if they had not sufficient room with-

in for such hot weather, which we believe is very much the case; for if cold or wet weather come on they stow themselves very well, and wait for fine weather. But swarming appears to be rather an operation arising from necessity, for they would seem not naturally to swarm, because if they have an empty space to fill they do not swarm; therefore by increasing the size of the hive the swarming is prevented. This period is much longer in some than in others. For some evenings before they come off is often heard a singular noise, a kind of ring, or sound of a small trumpet; by comparing it with the notes of the piano-forte, it seemed to be the same sound with the lower A of the treble. The swarm commonly consists of three classes; a female or females, males, and those commonly called mules, which are supposed to be of no sex, and are the labourers; the whole, about two quarts in bulk, making about six or seven thousand. It is a question that cannot easily be determined whether this old stock sends off entirely young of the same season, and whether the whole of their young ones, or only part. As the males are entirely bred in the same season, part go off; but part must stay, and most probably it is so with the others. They commonly come off in the heat of the day, often immediately after a shower. When one goes off they all immediately follow, and fly about seemingly in great confusion, although there is one principle actuating the whole. They soon appear to be directed to some fixed place; such as the branch of a tree or bush, the cavities of old trees, holes of houses leading into some hollow place; and whenever the stand is made, they immediately repair to it till they are all collected. But it would seem, in some cases, that they had not fixed upon any resting place before they come off, or, if they had, that they were either disturbed, if it was near, or that it was at a great distance; for, after hovering some time, as if undetermined, they fly away, mount up into the air, and go off with great velocity. When they have fixed upon their future habitation, they immediately begin to make their combs, for they have the materials within themselves. "I have reason," says Mr. Hunter, "to believe that they fill their crops with honey when they come away, probably from the stock in the hive. I killed several of those that came away, and found their crops full, while those that remained in the hive had their crops not near so full: some of them came away with farina on their legs, which I conceive to be rather accidental. I may just observe here, that a hive commonly sends off two, sometimes three swarms in a summer, but that the second is commonly less than the first, and the third less than the second; and this last has seldom time to provide for the winter.

"The materials of their dwelling or comb, which is the wax, is the next consideration, with the mode of forming, preparing, or disposing of it. In giving a totally new account of the wax, I shall first shew it can hardly be what it has been supposed to be. First, I shall observe that the materials, as they are found composing the comb, are not to be found in the same state (as a composition) in any vegetable, where they have been supposed to be got. The substance brought in on the legs, which is the farina of the flowers of plants, is, in common, I believe, imagined to be the materials of which the wax is made, for it is called by most the wax: but it is the farina, for it is always of the same colour as the farina of the flower where they are gathering; and, indeed, we see them gathering it, and we also see them covered almost all over with it like a dust; nevertheless, it has been supposed to be the wax, or that the wax was extracted from it. Reaumur is of this opinion. I made several experiments to see if there was such a quantity of oil in it, as would account for the quantity of wax to be formed, and to learn if it was composed of oil. I held it near the candle, it burnt, but did not smell like wax, and had the same smell, when burning, as farina when it was burnt. I observed that this substance was of different colours on different bees, but always of the same colour on both legs of the same bee; whereas a new made comb was all of one colour. I observed that it was gathered with more avidity for old hives, where the comb is complete, than for those hives where it only begun, which we could hardly conceive if it was the materials of wax: also we may observe that at the very beginning of a hive, the bees seldom bring in any substance on their legs for two or three days, and after that the farina gatherers begin to increase; for now some cells are formed to hold it as a store, and some eggs are laid, which when hatched will require this substance as food, and which will be ready when the weather is wet.

"The wax is formed by the bees themselves; it may be called an external secretion of oil, and I have found that it is formed between each scale of the under side of the

belly. When I first observed this substance, in my examination of the working bee, I was at a loss to say what it was: I asked myself if it was new scales forming, and whether they cast the old, as the lobster, &c. does? but it was to be found only between the scales on the lower side of the belly. On examining the bees through glass hives, while they were climbing up the glass, I could see that most of them had this substance, for it looked as if the lower, or posterior edge of the scale, was double, or that there were double scales: but I perceived it was loose, not attached. Finding that the substance brought in on their legs was farina, intended, as appeared from every circumstance, to be the food of the maggot, and not to make wax; and not having yet perceived any thing that could give me the least idea of wax, I conceived these scales might be it, at least I thought it necessary to investigate them. I therefore took several on the point of a needle, and held them to a candle, where they melted, and immediately formed themselves into round globules; upon which I no longer doubted but this was the wax, which opinion was confirmed to me by not finding those scales but in the building season.

"The cells, or rather the congeries of cells, which compose the comb, may be said to form perpendicular plates, or partitions, which extend from top to bottom of the cavity in which they build them, and from side to side. They always begin at the top or roof of the vault, in which they build, and work downwards; but if the upper part of this vault to which their combs are fixed, is removed, and a dome is put over, they begin at the upper edge of the old comb, and work up into the new cavity at the top. They generally may be guided as to the direction of their new plates of comb, by forming ridges at top, to which they begin to attach their comb. In a long hive, if these ridges are longitudinal, their plates of comb will be longitudinal; if placed transverse, so will be the plates; and if oblique, the plates of comb will be oblique. Each plate consists of a double set of cells, whose bottoms form the partition between each set. The plates themselves are not very regularly arranged, not forming a regular plane where they might have done so; but are often adapted to the situation or shape of the cavity in which they are built. The bees do not endeavour to shape their cavity to their work, as the wasps do, nor are the cells of equal depths, also fitting them to their situation; but as the breeding cells must all be of a given depth, they reserve a sufficient number for breeding in, and they put the honey into the others, as also into the shallow ones. The attachment of the comb round the cavity is not continued, but interrupted, so as to form passages; there are also passages in the middle of the plates, especially if there be a cross stick to support the comb; these allow of bees to go across from plate to plate. The substance which they use for attaching their combs to surrounding parts, is not the same as the common wax; it is softer and tougher, a good deal like the substance with which they cover in their chrysalis, or the humble-bee surrounds her eggs. It is probably a mixture of wax with farina. The cells are placed nearly horizontally, but not exactly so; the mouth raised a little, which probably may be to retain the honey the better; however, this rule is not strictly observed, for often they are horizontal, and towards the lower edge of a plane of comb they are often declining. The first combs that a hive forms are the smallest, and much neater than the last, or lowermost. Their sides or partitions, between cell and cell, are much thinner, and the hexagon is much more perfect. The wax is purer, being probably little else but wax, and it is more brittle. The lower combs are considerably larger, and contain much more wax, or perhaps, more properly, more materials; and the cells are at such distances as to allow them to be of a round figure: the wax is softer, and there is something mixed with it. I have observed that the cells are not all of equal size, some being a degree larger than the others; and that the small are the first formed, and of course at the upper part, where the bees begin, and the larger are nearer the lower part of the comb, or last made: however, in hives of particular construction, where the bees may begin to work at one end, and can work both down and towards the other end, we often find the larger cells both on the lower part of the combs, and also at the opposite end. These are formed for the males to be bred in; and in the hornets and wasps combs there are larger cells for the queens to be bred in: these are also formed in the lower tier, and the last formed.

"The first comb made in a hive is all of one colour, *viz.* almost white; but is not so white towards the end of the season, having then more of a yellow cast.

"There is a cell which is called the royal

cell, often three or four of them, sometimes more; I have seen eleven, and even thirteen in the same hive; commonly they are placed on the edge of one or more of the combs, but often on the side of a comb; however, not in the centre along with the other cells, like a large one placed among the others, but often against the mouths of the cells, and projecting out beyond the common surface of the comb; but most of them are formed from the edge of the comb, which terminates in one of these cells. The royal cell is much wider than the others, but seldom so deep: its mouth is round, and appears to be the largest half of an oval in depth, and is declining downwards, instead of being horizontal or lateral. The materials of which it is composed are softer than common wax, rather like the last mentioned, or those of which the lower edge of the plate of comb is made, or with which the bees cover the chrysalis: they have very little wax in their composition, not one third, the rest I conceive to be farina.

"The comb seems at first to be formed for propagation, and the reception of honey to be only a secondary use; for if the bees lose their queen they make no combs; and the wasp, hornet, &c. make combs although they collect no honey; and the humble-bee collects honey, and deposits it in cells she never made.

"I shall not consider the bee as an excellent mathematician, capable of making exact forms, and having reasoned upon the best shape of the cell for capacity, so that the greatest number might be put into the smallest space (for the hornet and the wasp are much more correct, although not seemingly under the same necessity, as they collect nothing to occupy their cells); because, although the bee is pretty perfect in these respects, yet it is very incorrect in others, in the formation of the comb: nor shall I consider these animals as forming combs of certain shape and size, from mere mechanical necessity, as from working round themselves; for such a mould would not form cells of different sizes, much less could wasps be guided by the same principle, as their cells are of very different sizes, and the first by much too small for the queen wasp to have worked round herself: but I shall consider the whole as an instinctive principle, in which the animal has no power of variation or choice, but such as arises from what may be called external necessity. The cell has in common six sides, but this is most correct in those first formed; and the bottom is commonly composed of those sides or planes, two of the sides making one; and they generally fall in between the bottoms of three cells of the opposite side; but this is not regular, it is only to be found where there is no external interruption.

"As soon as a few combs are formed, the female bee begins laying of eggs. As far as I have been able to observe, the queen is the only bee that propagates, although it is asserted that the labourers do. Her first eggs in the season are those which produce labourers; then the males, and probably the queen; this is the progress in the wasp, hornet, humble-bee, &c. However, it is asserted by Riem, that when a hive is deprived of a queen, labourers lay eggs; also, that at this time some honey and farina are brought in, as store for a wet day. The eggs are laid at the bottom of the cell, and we find them there before the cells are half completed, so that propagation begins early, and goes on along with the formation of the other cells. The egg is attached at one end to the bottom of the cell, sometimes standing perpendicularly, often obliquely; it has a glutinous, or slimy covering, which makes it stick to any thing it touches. It would appear that there was a period or periods for laying eggs; for I have observed in a new swarm that the great business of laying eggs did not last above a fortnight; although the hive was not half filled with comb, it began to slacken. In those new formed combs, as also in many not half finished, we find the substance called bee-bread, and some of it is covered over with wax, which will be considered further. By the time they have worked above half way down the hive with the comb, they are beginning to form for the larger cells, and by this time the first broods are hatched, which were small, or labourers; and now they begin to breed males, and probably a queen, for a new swarm; because the males are now bred to impregnate the young queen for the present summer as also for the next year. This progress in breeding is the same with that of the wasp, hornet, and humble-bee. Although this account is commonly allowed, yet writers on this subject have supposed another mode of producing a queen when the hive is in possession of maggots, and deprived of their queen.

"What may be called the complete process of the egg, namely, from the time of laying to the birth of the bee, (that is, the time of hatching) the life of the maggot, and the life of the chrysalis, is, I believe, shorter

than in most insects. It is not easy to fix the time when the eggs hatch: I have been led to imagine it was in five days. When they hatch we find the young maggot lying coiled up in the bottom of the cell, in some degree surrounded with a transparent fluid. In many of the cells, where the eggs have just hatched, we find the skin standing in its place, either not yet removed, or not pressed down by the maggot. There is now an additional employment for the labourers, namely, the feeding and nursing the young maggots. We may suppose the queen has nothing to do with this, as there are at all times labourers enough in the hive for such purposes, especially too, as she never does bring the materials, as every other of the tribe is obliged to do at first; therefore she seems to be a queen by hereditary, or rather by natural right, while the humble-bee, wasp, hornet, &c. seem rather to work themselves into royalty, or mistresses of the community. The bees are readily detected feeding the young maggot; and, indeed, a young maggot might easily be brought up by any person who would be attentive to it. They open their two lateral pincers to receive the food, and swallow it. As they grow, they cast their coats or cuticles; but how often they throw their coats, while in the maggot state, I do not know. The maggots grow larger and larger till they nearly fill the cell; and by this time they require no more food, and are ready to be inclosed for the chrysalis state: when ready for the chrysalis state, the bees cover over the mouth of the cell with a substance of a light brown colour, much in the same manner that they cover the honey, excepting that, in the present instance, the covering is convex externally, and appears not to be entirely wax, but a mixture of wax and farina. The maggot is now perfectly inclosed, and it begins to line the cell and covering of the mouth above-mentioned with a silk it spins out similar to the silkworm, and which makes a kind of pod for the chrysalis. Having completed this lining, they cast off, or rather shove off, from the head backwards, the last maggot coat which is deposited at the bottom of the cell, and then they become chrysalises.

"In this state they are forming themselves for a new life: they are either entirely new built, or wonderfully changed, for there is not the smallest vestige of the old form remaining; yet it must be the same materials, for now nothing is taken in. How far this change is only the old parts new modelled, or gradually altering their form, is not easily determined. To bring about the change, many parts must be removed, out of which the new ones are probably formed. As bees are not different in this state from the common flying insects in general, I shall not pursue the subject of their changes further, although it makes a very material part in the natural history of insects.

"When the chrysalis is formed into the complete bee, it then destroys the covering of its cell and comes forth. They are of a greyish colour, but soon turn brown.

"When the swarm of which I have hitherto been giving the history has come off early, and is a large one, more especially if it was put into too small a hive, it often breeds too many for the hive to keep through the winter; and in such case a new swarm is thrown off, which, however, is commonly not a large one, and generally has too little time to complete its comb, and store it with honey sufficient to preserve them through the winter. This is similar to the second or third swarm of the old hives.

"I have already observed that the new colony immediately sets about the increase of their numbers, and every thing relating to it. They had their apartments to build, both for the purpose of breeding, and as a store-house for provisions for the winter. When the season for laying eggs is over, then is the season for collecting honey; therefore, when the last chrysalis for the season comes forth, its cell is immediately filled with honey; and as soon as a cell is full, it is covered over with pure wax, as it is to be considered as store for the winter. This covering answers two very essential purposes: one is to keep it from spilling, or daubing the bees; the other to prevent its evaporation, by which means it is kept fluid in such a warmth. They are also employed in laying up a store of bee-bread for the young maggots in the spring, for they begin to bring forth much earlier than probably any other insect, because they retain a summer heat, and store up food for the young.

"In the month of August we may suppose the queen, or queens, are impregnated by the males; and as the males do not provide for themselves, they become burdensome to the workers, and are therefore teased to death much sooner than they otherwise would die; and when the bees set about this business of providing their winter store, every operation is over, except the collecting of honey and bee-bread. At this time

it would seem as if the males were conscious of their danger, for they do not rest in the mouth of the hive, in either going out or coming in, but hurry either in or out: however, they are commonly attacked by one, two, or three at a time: they seem to make no resistance, only getting away as fast as possible. The labourers do not sting them, only pinch them, and pull them about as if to wear them out; but I suspect it may be called as much a natural as a violent death.

"When the young are wholly come forth, and either the cells entirely filled, or no more honey to be collected, then is the time or season for remaining in their hives for the winter.

"Although I have now completed a hive, and no operations are going on in the winter months, yet the history of this hive is imperfect till it sends forth a new swarm.

"As the common bee is very susceptible of cold, we find as soon as the cold weather sets in, they become very quiet or still, and remain so throughout the winter, living on the produce of the summer and autumn; and, indeed, a cold day in the summer is sufficient to keep them at home, more so than a shower in a warm day: and if the hive is thin and much exposed, they will hardly move in it, but get as close together as the comb will let them, into a cluster. In this manner they appear to live through the winter: however, in a fine day they become very lively and active, going abroad, and appearing to enjoy it, at which time they get rid of their excrement: for I fancy they seldom throw out their excrement when in the hive.

"Their life at this season of the year is more uniform, and may be termed simple existence, till the warm weather arrives again. As they now subsist on their summer's industry, they would seem to feed in proportion to the coldness of the season; for from experiment, I found the hive grow lighter in a cold week than it did in a warmer, which led to further experiments.

"Although an indolent state is very much the condition of bees through the winter, yet progress is making in the queen towards a summer's increase. The eggs in the oviducts are beginning to swell, and, I believe, in the month of March she is ready to lay them, for the young bees are to swarm in June; which constitutes the queen bee to be the earliest breeder of any insect we know. In consequence of this the labourers become sooner employed than any other of this tribe of insects. This, both queen and labourers are enabled to accomplish, from living in society through the winter; and it becomes necessary in them, as they have their colony to form early in the summer, which is to provide for itself for the winter following. All this requires the process to be carried forward earlier than by any other insect, for these are only to have young, which are to take care of themselves through the summer, not being under the necessity of providing for the winter.

"The queen bee, as she is termed, has excited more curiosity than all the others, although much more belongs to the labourers. From the number of these, and from their exposing themselves, they have their history much better made out: but as there is only one queen, and she scarcely ever seen, it being only the effects of her labour we can come at, an opportunity has been given to the ingenuity of conjecture, and more has been said than can well be proved. The queen, the mother of all, in whatever way produced, is a true female, and different from both the labourers and the male. She is not so large in the trunk as the male, and appears to be rather larger in every part than the labourers. The scales on the under surface of the belly of the labourers are not uniformly of the same colour over the whole scale, that part being lighter which is overlapped by the terminating scale above, and the uncovered part being darker. This light part does not terminate in a straight line, but in two curves, making a peak; all which gives the belly a lighter colour in the labouring bees, more especially when it is pulled out or elongated. We distinguish a queen from a working bee simply by size, and in some degree by colour; but this last is not so easily ascertained, because the difference in the colour is not so remarkable in the back, and the only view we can commonly get of her is on this part; but when a hive is killed, the best way is to collect all the bees, and spread them on white paper, or put them into water, in a broad, flat-bottomed, shallow, white dish, in which they swim, and by looking at them singly she may be discovered. As the queen breeds the first year she is produced, and the oviducts never entirely subside, an old queen is probably thicker than a new-bred one, unless indeed the oviducts and the eggs form in the chrysalis state, as in the silk-worm, which I should suppose they did. The queen is perhaps at the smallest size just as she has done breeding; for as she is to lay eggs by the month of March, she must begin

early to fill again; but I believe her oviducts are never emptied, having at all times eggs in them, although but small. She has fat in her belly, similar to the other bees.

"It is most probable that the queen which goes off with the swarm is a young one, for the males go off with the swarm to impregnate her, as she must be impregnated the same year, because she breeds the same year.

"The queen has a sting similar to the working bee.

"I believe a hive, or swarm, has but one queen, at least I have never found more than one in a swarm, or in an old hive in the winter; and probably this is what constitutes a hive; for when there are two queens, it is likely that a division may begin to take place. Supernumerary queens are mentioned by Riem, who asserts he has seen them killed by the labourers as well as the males.

"The male bee is considerably larger than the labourers: he is even larger than the queen, although not so long when she is in her full state with eggs: he is considerably thicker than either, but not longer in the same proportion: he does not terminate at the anus in so sharp a point; and the opening between the two last scales of the back and belly is larger, and more under the belly, than in the female. His proboscis is much shorter than that of the labouring bee, which makes me suspect he does not collect his own honey, but takes that which is brought home by the others; especially as we never find the males abroad on flowers, &c. only flying about the hives in hot weather, as if taking an airing; and when we find that the male of the humble bee, which collects its own food, has as long a proboscis, or tongue, as the female, I think it is from all these facts reasonable to suppose the male of the common bee feeds at home. He has no sting.

"The class of labouring bees, for we cannot call it either sex or species, is the largest in number of the whole community: there are thousands of them to one queen, and probably some hundreds to each male. It is to be supposed they are the only bees which construct the whole hive, and that the queen has no other business but to lay the eggs: they are the only bees that bring in materials; the only ones we observe busy abroad; and indeed the idea of any other is ridiculous, when we consider the disproportion in numbers, as well as the employment of the others, while the working bee has nothing to take off its attention to the business of the family. They are smaller than either the queen or the males: not all of equal size, although the difference is not very great.

"The queen and the working bees are so much alike, that the latter would seem to be females on a different scale: however, this difference is not so observable in the beginning of winter as in the spring, when the queen is full of eggs. They are all females in construction; indeed, one might suppose that they were only young queens, and that they became queens after a certain age; but this is not the case. They all have stings, which is another thing that makes them similar to the queen. From their being furnished with an instrument of defence and offence, they are endowed with such powers of mind as to use it, their minds being extremely irritable; so much so, that they make an attack when not meddled with, simply upon suspicion, and when they do attack they always sting; and yet, from the circumstance of their not being able to disengage the sting, one should suppose they would be more cautious in striking with it. When they attack one another, they seldom use it, only their pincers; yet I saw two bees engaged, and one stung the other in the mouth, or thereabouts, and the sting was drawn from the body to which it belonged, and the one who was stung ran very quickly about with it; but I could not catch that bee, to observe how the sting was situated.

"As they are the collectors of honey, much more than what is for their own use either immediately or in future, their tongue is proportionably fitted for that purpose: it is considerably longer than that of either the queen or the male, which fits them to take up the honey from the hollow parts of flowers of considerable depth. The mechanism is very curious, and will be explained further on.

"Bees certainly have the five senses: sight none can doubt: feeling they also have; and there is every reason for supposing they have likewise taste, smell, and hearing. Taste we cannot doubt; but of smell we may not have such proofs; yet, from observation, I think they give strong signs of smell. When bees are hungry, as a young swarm in wet weather, and are in a glass hive, so that they can be examined, if we put some honey into the bottom, it will immediately breed a commotion; they all seem to be upon the scent: even if they are weak, and hardly able to crawl, they will throw out their probosces as far as possible to get to it, although the light is very

faint. This last appears to arise more from smell than seeing. If some bees are let loose in a bee-hive, and do not know from which house they came, they will take their stand upon the outside of some hive, or hives, especially when the evening is coming on: whether this arises from the smell of the hives, or sound, I can hardly judge.

"Bees may be said to have a voice. They are certainly capable of forming several sounds. They give a sound when flying, which they can vary according to circumstances. One accustomed to bees can immediately tell when a bee makes an attack, by the sound. This is probably made by the wings. They may be seen standing at the door of their hive, with the belly rather raised, and moving their wings, making a noise. But they produce a noise independent of their wings; for if a bee is smeared all over with honey, so as to make the wings stick together, it will be found to make a noise which is shrill and peevish. I have observed that they, or some of them, make a noise the evenings before they swarm, which is a kind of ring, or sound of a small trumpet: by comparing it with the notes of the piano-forte, it seemed to be the same with the lower A of the treble.

"I have observed that it is only the queen and the labourers that have stings; and this provision of a sting is perhaps as curious a circumstance as any attending the bee, and probably is one of the characters of the bee tribe.

"The apparatus itself is of a very curious construction, fitted for inflicting a wound, and at the same time conveying a poison into that wound. The apparatus consists of two piercers, conducted in a groove or director, which appears to be itself the sting. All these parts are moved by muscles, which we may suppose are very strong in them, much stronger than in other animals; and these muscles give motion in almost all directions, but more particularly outwards. It is wonderful how deep they will pierce solid bodies with the sting. I have examined the length they have pierced the palm of the hand, which is covered with a thick cuticle: it has often been about the $\frac{1}{12}$th of an inch. To perform this by mere force, two things are necessary, power of muscles, and strength of the sting, neither of which they seem to possess in sufficient degree. I own I do not understand this operation. I am apt to conceive there is something in it distinct from simple force applied to one end of a body; for if this was simply the case, the sting of the bee could not be made to pierce by any power applied to its base, as the least pressure bends it in any direction: it is possible the serrated edges may assist, by cutting their way in like a saw.

"The apparatus for the poison consists of two small ducts, which are the glands that secrete the poison: these two lie in the abdomen, among the air-cells, &c.: they both unite into one, which soon enters into or forms an oblong bag, like a bladder of urine; at the opposite end of which passes out a duct, which runs towards the angle where the two stings meet, and entering between the two stings, is continued between them in a groove, which forms a canal by the union of the two stings to this point. There is another duct on the right of that described above, which is not so circumscribed, and contains a thicker matter, which, as far as I have been able to judge, enters along with the other; but it is the first that contains the poison, which is a thin, clear fluid. From the stings having serrated edges, it is seldom the bees can disengage them; and they immediately upon stinging endeavour to make their escape, but are generally prevented, as it were caught in their own trap; and the force they use commonly drags out the whole of the apparatus for stinging, and also part of the bowels; so that the bee most frequently falls a sacrifice immediately upon having effected its purpose. Upon a superficial view, one conceives that the first intention of the bee having a sting is evident; one sees it has property to defend, and that therefore it is fitted for defence; but why it should naturally fall a sacrifice in its own defence does not so readily appear: besides, all bees have stings, although all bees have not property to defend, and therefore are not under the same necessity of being so provided. Probably its having a sting to use was sufficient for nature to defend the bee, without using it liberally; and the loss of a bee or two, when they did sting, was of no consequence; for it is seldom that more die."

We now proceed to notice some of the species. The apis centuncularis, or carpenter-bee, is remarkable for its faculty of forming long, tubular, and slightly flexuose cavities in wood, even of the most solid kind, as oak, &c. Sometimes it performs this operation in living trees, and sometimes in dry wood, posts, &c. When the tube is properly finished, the animal proceeds to line each of the above-mentioned spaces with rose-leaves rolled over each other, the

bottom of each being formed by several circular pieces of these leaves placed immediately over each other to a sufficient thickness. The animal then deposits an egg at the bottom, and having left in the cell a sufficient quantity of a kind of honey for the nourishment of the young larva when hatched, proceeds to close the top with circular bits of rose-leaf; and thus proceeding, finishes the whole series. This is usually done towards the close of summer; and the young, having passed the period of their larva state, change into that of chrysalis, and remain the whole winter, not making their appearance till pretty late in the ensuing season. This bee is about the size of the common, or honey-bee, but shorter and broader bodied in proportion, and is of a dusky colour above, the lower parts being covered with a bright ferruginous down or hair. In seasons when this species happens to be plentiful, it does considerable injury to the trees which it attacks, large trunks of apparently healthy oaks having been found very materially injured by the numerous trains of cells distributed through them in different parts; thirty, forty, or fifty tubes sometimes lying within a very small distance of each other. In defect of rose-leaves the cavities are sometimes lined with the leaves of elm, &c. A species very nearly allied to the preceding pursues a similar plan of forming a continued series of cylindrical nests with rose or other leaves, rolling them in such a manner as to resemble so many thimbles, the top of each being closed as before. Instead, however, of being placed in the timber of trees, they are laid in horizontal trains at a certain distance beneath the surface of the ground. Of the villose, or hairy bees, popularly called humble-bees, one of the largest and most common is the apis lapidaria of Linnæus, so named from the circumstance of its nest being generally situated in strong or gravelly places. This species is entirely of a deep black colour, except the end of the abdomen, which is red or orange-coloured, more or less deep in different individuals. The female is of large size, measuring near an inch in length; the male is considerably smaller; and the neuter, or labouring bee, still smaller than the male. The humble-bees in general live in small societies of 40 or 60 together, in an oval or roundish nest, excavated to a small depth beneath the surface of the ground, and formed of branches of moss, compacted together, and lined with a kind of coarse wax. In this nest, which measures from four to six inches in diameter, are constructed several oval cells, which, however, are not the work of the complete insects, but are the cases spun by the larvæ, and in which they remain during their state of chrysalis: the eggs are deposited among heaps of a kind of coarse honey or bee-bread, placed here and there at uncertain intervals; on this substance the larvæ feed during their growing state: lastly, in every nest are placed a few nearly cylindric cells or goblets of coarse wax, and filled with pure honey, on which the complete insects feed. See Plate I, Entomology, fig. 4—6. For the management of bees see BEE.

APIUM, in botany, a genus of plants, including parsley, smallage, and celery. Class, Pentandria Digynia; natural order of Umbellatæ. Essen. character, cal. general umbel of fewer rays than those of the partial; cor. general uniform; floscules almost all fertile; petals roundish, inflex, equal; stam. filaments simple; anthers roundish; pist. germ inferior; seeds two, ovate, striated on one side, plane on the other. A. petrosilinum, or common parsley; both the varieties are in use; but it is remarked that the plane-leaved sort is most commonly cultivated, though many prefer the curled kind, because its leaves are most easily distinguished from the æthusa, or fool's parsley, a sort of hemlock, and a poisonous garden weed, which, while young, has great resemblance to the common plane-leaved parsley. Besides, the curled parsley, from its having larger and thicker leaves, and being curiously fimbriated and curled, so as to shew full and double, makes a better appearance in its growth, and is more esteemed by cooks for the purpose of garnishing dishes, &c. It may, however, be necessary to remark, that this sort, as being only a variety, is liable to degenerate to the common plane sort, unless particular care be taken to save the seed always from the perfect, full curled plants. Both the varieties are propagated by seed sown annually in spring, where the plants are to remain; but the plants, are biennials, rising from seed sown in March, April, May, and June. A. latifolium, or broad-leafed parsley. The propagation of this species is also by seed sown annually in February, March, April, or May, where the plants are to remain. For this purpose, a spot of light rich earth, in an open exposure, is to be preferred; the seed being sown broad-cast, and raked in, the plants generally appearing in about a month after being sown, and in May or June they

require to be thinned and cleared from weeds, which may be performed either by hand or hoe; but the latter is most eligible, as it will stir and loosen the surface of the earth, which may be beneficial to the plants, cutting them out to about six inches distance from each other. In the latter end of July, the roots will mostly have attained a size proper for use; and may be drawn occasionally; but they seldom acquire their full growth till about Michaelmas. This is sometimes called Hamburgh parsley, probably from its being much cultivated about that place. It is chiefly cultivated and esteemed for its large roots, which are white and carrot-shaped, being long, taper, and of downright growth, often attaining the size and appearance of small or middling parsnips; they boil exceedingly tender and palatable, are very wholesome, and may be used in soup or broth, or to eat like carrots and parsnips, or as sauce to flesh meat. A. dulce, or the common celery. The method of propagation in all the varieties of this sort, is by sowing the seed in the spring, and when the plants have attained six or eight inches in height, transplanting them into trenches, in order to be earthed up on each side as they advance in growth, and have their stalks blanched or whitened, to render them crisp and tender.

APLANATIC, in optics, a term applied by Dr. Blair, professor of astronomy in Edinburgh, to that kind of refraction discovered by himself, which corrects the aberration of the rays of light, and the colour depending upon it, in contradistinction to the word achromatic, which has been appropriated to that refraction in which there is only a partial correction of colour. See OPTICS. Dr. Blair discovered a mixture of solutions of ammoniacal and mercurial salts, and also some other substances, which produced dispersions proportional to that of glass, with respect to the different colours; and he constructed a compound lens consisting of a semi-convex one of crown glass, with its flat side towards the object, and a meniscus of the same materials, with its convex side in the same direction, and its flatter concave next the eye, and the interval between these lenses he filled with a solution of antimony in a certain proportion of muriatic acid. The lens thus adapted did not manifest the slightest vestige of any extraneous colour. He obtained a patent for the invention in 1791.

APLUDA, in botany, a genus of the Polygamia Monoecia class of plants, the common calyx of which is an univalve, bifloral, ovated, concave, loose, mucronated glume; the proper glume is bivalve, and placed obliquely; the corolla is a bivalve glume of the length of the cup; there is no pericarpium; the seed, which is single, is involved in the glume of the corolla. Male corol. two valved; female floret sessile; stamina three. Female corol. two-valved; one style; one seed, covered. There are four species.

APOCOPE, among grammarians, a figure which cuts off a letter or syllable from the end of a word, as *ingeni* for *ingenii*.

APOCRYPHAL, something dubious, is more particularly applied to certain books not admitted into the canon of scripture. Those are certain books of the Old Testament extant only in Greek, admitted by the church of Rome as canonical, but rejected by the reformed churches as no part of holy writ; such are the books of Judith, Wisdom, Tobit, Baruch, Maccabees, the third and fourth books of Esdras. In this sense apocryphal stands distinguished from canonical, though the Romish church disowns the distinction. Authors are divided as to the origin of the appellation apocryphal, and the reason why it was given to these books. The apocryphal books were not received into the canon, either of the Jews, or ancient Christians, but were first made canonical by a decree of the council of Trent. The apocryphal books, according to the sixth article of the church of England, are to be read for example of life and instruction of manners; but it doth not apply them to establish any doctrine.

APOCYNUM, in botany, a genus of the Pentandria Dygnia class and order. Corol. campanulate; nectareous filaments five, alternating with the stamina. There are 14 species.

APODES, the name of one of the orders of fishes in the Linnæan distribution of animals. Their character is that they have no belly fins: there are 12 genera, *viz.*

Ammodytes,	Ophydium,
Anarchichas,	Sternoptyx,
Gymnothorax,	Stromateus,
Gynotus,	Stylephorus,
Leptocephalus,	Trichiurus,
Muræna,	Xiphias,

which see under the several heads in the alphabet.

APOGEE, in astronomy, that point of the orbit of a planet, or the sun, which is farthest from the earth.

Ancient astronomy, which placed the

earth in the centre of the system, was much taken up in ascertaining the apogee and perigee; which the moderns have changed for aphelium and perihelium. See the article APHELIUM, &c.

APOLLONIUS, of Perga, a city in Pamphilia, was a celebrated geometrician who flourished in the reign of Ptolemy Euergetes, about 240 years before Christ; being about 60 years after Euclid, and 30 years later than Archimedes. He studied a long time in Alexandria under the disciples of Euclid; and afterwards he composed several curious and ingenious geometrical works, of which only his books of Conic Sections are now extant, and even these not perfect. For it appears from the author's dedicatory epistle to Eudemus, a geometrician in Pergamus, that this work consisted of eight books; only seven of which however have come down to us.

From the Collections of Pappus, and the Commentaries of Eutocius, it appears that Apollonius was the author of various pieces in geometry, on account of which he acquired the title of the great geometrician. His Conics was the principal of them. Some have thought that Apollonius appropriated the writings and discoveries of Archimedes; Heraclius, who wrote the life of Archimedes, affirms it; though Eutocius endeavours to refute him. Although it should be allowed a groundless supposition, that Archimedes was the first who wrote upon conics, notwithstanding his treatise on conics was greatly esteemed; yet it is highly probable that Apollonius would avail himself of the writings of that author, as well as others who had gone before him; and, upon the whole, he is allowed the honour of explaining a difficult subject better than had been done before; having made several improvements both in Archimedes's problems, and in Euclid. His work upon conics was doubtless the most perfect of the kind among the ancients, and in some respects among the moderns also. Before Apollonius, it had been customary, as we are informed by Eutocius, for the writers on conics to require three different sorts of cones to cut the three different sections from; *viz.* the parabola from a right-angled cone, the ellipse from an acute, and the hyperbola from an obtuse cone; because they always supposed the sections made by a plane cutting the cones to be perpendicular to the side of them: but Apollonius cut his sections all from any one cone, by only varying the inclination or position of the cutting plane; an improvement that has been followed by all other authors since his time. But that Archimedes was acquainted with the same manner of cutting any cone, is sufficiently proved, against Eutocius, Pappus, and others, by Guido Ubaldus, in the beginning of his Commentary on the 2d book of Archimedes's Equiponderantes, published at Pisa in 1588. See CONIC SECTIONS.

The first four books of Apollonius's conics only have come down to us in their original Greek language; but the next three, the 5th, 6th, and 7th, in an Arabic version; and the 8th not at all. These have been commented upon, translated, and published by various authors. Pappus, in his Mathematical Collections, has left some account of his various works, with notes and lemmas upon them, and particularly on the Conics. And Eutocius wrote a regular elaborate commentary on the propositions of several of the books of the Conics.

A neat edition of the first four books in Latin was published by Dr. Barrow, in 4to. at London, in 1675. A magnificent edition of all the books was published in folio, by Dr. Halley, at Oxford, in 1710; together with the Lemmas of Pappus, and the Commentaries of Eutocius. The first four in Greek and Latin, but the latter four in Latin only, the 8th book being restored by himself.

APOLOGUE, in matters of literature, an ingenious method of conveying instruction by means of a feigned relation, called a moral fable.

The only difference between a parable and an apologue is, that the former being drawn from what passes among mankind, requires probability in the narration: whereas the apologue being taken from the supposed actions of brutes, or even of things inanimate, is not tied down to the strict rules of probability. Æsop's fables are a model of this kind of writing.

APONOGETON, in botany, a genus of the Dodecandria Tetragynia. Ament composed of scales; no calyx, no corol; capsules four; three seeded. There are four species.

APOPHTHEGM, a short, sententious, and instructive remark, pronounced by a person of distinguished character. Such are the apophthegms of Plutarch, and those of the ancients collected by Lycosthenes.

APOPHYSIS, in anatomy, an excrescence from the body of a bone, of which it is a true continuous part, as a branch is of a tree.

APOTHECARY, one who practises the art of pharmacy, or that part of physic which consists in the preparation and composition of medicines.

A youth intended for this profession, should be a pretty good scholar, and have such a knowledge in the Latin tongue, as to be able to read the best writers upon the subject of botany, pharmacy, anatomy, and medicine. In London, the apothecaries are one of the city companies, and by an act which was made perpetual in the ninth year of George I. are exempted from serving upon juries, or in ward and parish offices. They are obliged to make up their medicines according to the formulas prescribed in the College Dispensatory, and are liable to have their shops visited by the censors of the college, who are impowered to destroy such medicines as they think not good.

The apothecaries have a hall in Blackfriars, where there are two fine laboratories, from which all the surgeons' chests are supplied with medicines for the royal navy. In China, they have a singular mode of dispensing their medicines. In the public squares of their cities there is a very high stone pillar, on which are engraven the names of all sorts of medicines, with the price of each; and when the poor stand in need of any relief from physic, they go to the treasury, where they receive the price each medicine is rated at.

APOTHEOSIS, in antiquity, a ceremony by which the ancient Romans complimented their emperors and great men, after their death, with a place among the gods. It is described as follows: after the body of the deceased had been burnt with the usual solemnities, an image of wax, exactly resembling him, was placed on an ivory couch, where it lay for seven days, attended by the senate and ladies of the highest quality in mourning; and then the young senators and knights bore the bed of state through the Via sacra to the old Forum, and from thence to the Campus Martius, where it was deposited upon an edifice built in form of a pyramid. The bed being thus placed, amidst a quantity of spices and other combustibles, and the knights having made a procession in solemn measure round the pile, the new emperor, with a torch in his hand, set fire to it, while an eagle, let fly from the top of the building, and mounting in the air with a firebrand, was supposed to convey the soul of the deceased to heaven, and thenceforward he was ranked among the gods.

APOTOME, in geometry, the difference between two incommensurable lines: thus, E C, (Plate Miscel. fig. 6.) is the apotome of A C and A B.

If we suppose A C $= a$, and A B $= b$, then will their apotome be $a - \sqrt{b}$; or, in numbers, $2 - \sqrt{3}$. Hence also the difference between the side A C $= 2$ (fig. 7.) of an equilateral triangle A B C, and the perpendicular B D $= \sqrt{3}$ is an apotome, *viz.* $= 2 - \sqrt{3}$. And, universally, if A C (fig. 8.) be a semi-parabola, whose axis is A B, and its latus rectum $= 1$, and if A D be a tangent to the vertex at A, and this be divided into the parts A $a = 2$, A $b = 3$, A $c = 5$, A $d = 6$, &c. and perpendiculars a 1, b 2, c 3, d 4, &c. be drawn, these will be, from the nature of the curve, $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, $\sqrt{6}$, &c. respectively; and so $\frac{1}{2}$ A $a (= 1) - a$ 1, will be $1 - \sqrt{2}$; A $a - b$ 2 will be $2 - \sqrt{3}$, &c. by which means you will have an infinite series of different apotomes.

APOTOME, in music, the difference between a greater and lesser semi-tone, expressed by the ratio 128 : 125.

APPARATUS, a term used to denote a complete set of instruments, or other utensils, belonging to any artist or machine: thus we say a surgeon's apparatus, a chemist's apparatus, the apparatus of the air-pump, microscope, &c.

APPARENT, among mathematicians and astronomers, denotes things as they appear to us, in contradistinction from real or true: thus we say, the apparent diameter, distance, magnitude, place, figure, &c. of bodies.

APPARITOR, among the Romans, a general term to comprehend all attendants of judges and magistrates appointed to receive and execute their orders. Apparitor, with us, is a messenger, that serves the process of a spiritual court, or a beadle in an university, who carries the mace.

APPAUMEE, in heraldry, denotes one hand extended with the full palm appearing, and the thumb and fingers at full length.

APPEAL, in law, the removal of a cause from an inferior to a superior court or judge, when a person thinks himself aggrieved by the sentence of the inferior judge. Appeals lie from all the ordinary courts of justice to the House of Lords. In ecclesiastical causes, if an appeal is brought before a bishop, it may be removed to the archbishop; if before an archdeacon, to the Court of Arches,

and thence to the archbishop; and from the archbishop's court to the king in chancery.

Appeal, in common law, is taken for the accusation of a murderer by a person who had interest in the party killed; or of a felon by an accomplice. It is prosecuted either by writ or by bill: by writ, when a writ is purchased out of the Chancery by one person against another, commanding him to appeal some third person of felony, and to find pledges for doing it effectually; by bill, when the person himself gives in his accusation in writing, offering to undergo the burden of appealing the person therein named.

In military affairs, an appeal might formerly be made by the prosecutor, or prisoner, from the sentence or jurisdiction of a regimental to a general court-martial. At present no soldier has a right to appeal, except in cases where his immediate subsistance is concerned.

APPEARANCE, in law, signifies a defendant's filing a common or special bail on any process issued out of a court of judicature. In actions by original, appearances are entered with the philazer of the county; and by bill, with the prothonotary. Defendants may appear in person, where the party stands in contempt, for the court will not permit him to appear by attorney: also in capital, and criminal cases; where an act of parliament requires that the party should appear in person, and likewise in appeal, or on attachment: by attorney, in all actions, real, personal, and mixed, and for any crime whatever under the degree of capital, by favour of the court: by guardian and next friend, when under age.

APPELLATIVE, in grammar, a noun, or name, which is applicable to a whole species or kind, as man, horse; in contradistinction to a proper name.

APPELLOR, or Appellant, in law, he who has committed some felony, or other crime, which he confesses and appeals, that is, accuses his accomplices.

APPENDANT, in law, any thing that is inheritable, belonging to some more worthy inheritance; as an advowson, common, or court, may be appendant to a manor, land to an office, &c. but land cannot be appendant to land, for both are corporeal inheritances, and one thing corporeal cannot be appendant to another.

APPLE, a well-known fruit, consisting of a rind, pill, or skin; the pulp, or parenchyma; the branchery, or seed-vessels; and the core. See Pyrus.

APPLICATION, the act of applying one thing to another, by causing them to approach, or bringing them nearer together. Thus a longer line or space is measured by the application of a less, as a foot or yard by an inch, &c.: and motion is determined by successive application of any thing to different parts of space. Application is sometimes also used, both in arithmetic and geometry, for the operation of division, or for that which corresponds to it in geometry. Thus 20 applied to, or divided by 4, *i. e.* $\frac{20}{4}$, gives 5. And a rectangle $a\,b$ applied to a line, c, gives the fourth proportional $\frac{a\,b}{c}$, or another line, as d, which, with the given line c, will contain a rectangle $c\,d = a\,b$.

Application, in geometry, denotes the act of placing one figure upon another, in order to determine their equality or inequality. In this way Euclid, and other geometricians, have demonstrated some of the primary and fundamental propositions in elementary geometry. Thus it is proved, that two triangles, having two sides of the one equal respectively to two sides of the other, and the two included angles equal, are equal in all respects; and two triangles, having one side and the adjacent angles of the one respectively equal to one side, and the adjacent angles of the other, are also in the same mode of application shewn to be equal. Thus also it is demonstrated that a diameter divides the circle into two equal parts; and that the diagonal divides a square or parallelogram into two equal parts. The term is also used to signify the adaptation of one quantity to another, in order to their being compared; the areas of which are the same, but their figures different. Thus Euclid shews how, on a right line given, to apply a parallelogram that shall be equal to a right-lined figure given.

Application *of one science to another*, signifies the use that is made of the principles of the one for augmenting and perfecting the other. As there is a connection between all the arts and sciences, one of them may be made subservient to the illustration and improvement of the other: and to this purpose algebra has been applied to geometry, and geometry to algebra, and both to mechanics, astronomy, geography, navigation, &c. See Algebra, *application of.*

Application *of algebra and geometry to*

mechanics is founded on the same principles as the application of algebra to geometry. It consists principally in representing by equations the curves described by bodies in motion, by determining the equation between the spaces which the bodies describe when actuated by any forces, and the times employed in describing them. As a familiar instance, we may refer to the article Acceleration, where the perpendiculars of triangles represent the times, the bases the velocities, and the areas the spaces described by bodies in motion, a method first invented by Galileo. As lines and figures may be treated of algebraically, it is evident in what way the principles of geometry and algebra may be applied to mechanics, and indeed to every branch of mixt mathematics.

Application *of mechanics to geometry* consists in the use that is made of the centre of gravity of figures for determining the contents of solid bodies described by those figures.

Application *of geometry and astronomy to geography* consists in determining the figure and magnitude of the earth; in determining the positions of places by observations of latitudes and longitudes; and in determining by geometrical operations the positions of such places as are not far distant from one another.

Application *of geometry and algebra to natural philosophy* was invented chiefly by Sir Isaac Newton, and upon this application are founded all the mixed sciences of mathematical and natural philosophy. Here a single observation or experiment will frequently produce a whole science, or branch of science. Thus, when it is proved by experiment that the rays of light, in reflecting, make the angle of incidence equal to the angle of reflection, we deduce the whole science of catoptrics; for this fact being established, catoptrics becomes a science purely geometrical, since it is reduced to the comparison of angles and lines given in position.

APPOINTEE, in heraldry, the same as aguisée: thus we say, a cross appointée, to signify that which has two angles at the end cut off, so as to terminate in points.

APPORTIONMENT, in law, the division of a rent into parts, in the same manner as the land out of which it issues is divided: for example, if a person leases three acres of land for a certain rent, and afterwards grants away one acre thereof to another: the rent shall be apportioned between them.

APPOSITION, in grammar, the placing two or more substantives together, in the same case, without any copulative conjunction between them; as, *ardebat Alexim delicias domini.*

APPRAISING, the valuing or setting a price on goods. This is usually done by a sworn appraiser, who, if he values the goods too high, is obliged to take them at the price appraised.

APPREHENSION, in logic, the first or most simple act of the mind, whereby it perceives, or is conscious of some idea: it is more usually called perception.

APPRENTICE, a young person bound by indenture to some tradesman, in order to be instructed in the mystery or trade. By the laws of England, a master may be indicted for not providing for, or for turning away his apprentice: and upon complaint from a master, that he neglects his duty, an apprentice may be committed to Bridewell, or be bound over to the sessions. Apprentices may be bound to husbandmen, or even to gentlemen of fortune and clergymen, who, as well as tradesmen, are compellable to take the children of the poor, under a penalty of 10*l.* And the church-wardens and overseers, with the consent of two justices, may bind them till the age of 21 years. Justices may compel certain persons under age to be bound apprentices, and on refusal may commit them. Apprentices may be discharged on reasonable cause, either at their own request or that of their masters. If any, whose premium has been less than ten pounds, run away from their masters, they are compellable to serve out the time of absence, or give satisfaction for it, any period within seven years after the expiration of the original contract. Indentures are to be stamped, and are chargeable with several duties by act of parliament.

APPRENTICESHIP, denotes the servitude of an apprentice, or the duration of his indenture. The competition in several employments is restrained to a smaller number, than would otherwise be disposed to enter into them, partly by the limitation of the number of apprentices, which attends the exclusive privilege of incorporated trades; and partly by the long term of apprenticeship, which increases the expense of education. Seven years seem formerly to have been, all over Europe, the usual term established for the duration of apprenticeships in the greater number of incorporated trades. Such incorporations were anciently called universities,

which is the proper Latin name for any incorporation whatever. The university, of smiths, the university of tailors, &c. are expressions commonly occurring in the old charters of ancient towns. When those particular incorporations, which are now peculiarly called universities, were first established, the term of years during which it was necessary to study, in order to obtain the degree of Master of Arts, appears evidently to have been copied from the term of apprenticeship in common trades, of which the incorporations were much more ancient. As to have wrought seven years under a master properly qualified, was necessary to entitle any person to become a master, and to have himself apprentices, in a common trade, so to have studied seven years under a master properly qualified, was necessary to entitle him to become a master, teacher, or doctor (words anciently synonymous) to study under him. By the 5th of Elizabeth, commonly called the statute of apprenticeship, it was enacted, that no person should, for the future, exercise any trade, craft, or mystery, at that time exercised in England, unless he had previously served to it an apprenticeship of seven years at least; and thus, what before had been the bye-law of many particular corporations, became in England the general and public law of all trades carried on in market-towns. To country villages the term of seven years apprenticeship doth not extend; but the limitation of this statute to trades exercised before it was passed, has given occasion to several distinctions, which, considered as rules of police, appear as foolish as can well be imagined. A coachmaker, for instance, has no right to make, or employ journeymen for making, coach-wheels: but he must buy them of a master wheel-wright, this latter trade having been exercised in England before the 5th of Elizabeth. But a wheel-wright, though he has never served an apprenticeship to a coachmaker, may, by himself or journeyman, make coaches, because this trade, being of a later origin, is not within the statute. Thus also the manufactures of Manchester, Birmingham, and Wolverhampton, are, many of them, upon this account, not within the statute, not having been exercised in England before the 5th of Elizabeth.

The regulations of apprenticeship in Ireland are upon a different footing, and somewhat less illiberal than in England. Prohibitions similar to those of the statute of the 5th of Elizabeth, obtain in all corporate towns, by authority of bye-laws of the several corporations: but these prohibitions extend only to natives of Ireland; for by a regulation made by the lord lieutenant and privy-council having in this instance, by 17 and 18 Car. II. the force of a law, all foreigners and aliens, as well persons of other religious persuasion as Protestants, who are merchants, traders, artificers, &c. shall, upon coming to reside in a city, walled town, or corporation, and paying twenty shillings, by way of fine to the chief magistrate and common-council, or other persons authorized to admit freemen, be admitted to the freedom of that city, &c. and to the freedom of guilds of their respective trades, with the full enjoyment of all privileges of buying, selling, working, &c.; and any magistrate refusing to admit foreigners so applying, shall be disfranchised.

In Scotland, there is no general law which regulates universally the duration of apprenticeships. The term is different in different corporations; where it is long, a part of it may generally be redeemed by paying a small fine. In most towns, too, a very small fine is sufficient to purchase the freedom of any corporation. The weavers of linen and hempen cloth, the principal manufactures of the country, as well as all other artificers subservient to them, wheel-makers, reel-makers, &c. may exercise their trades in any town corporate, without paying any fine. In all towns corporate, all persons are free to sell butchers' meat upon any lawful day of the week. Three years are, in Scotland, a common term of apprenticeship, in some very nice trades; and, in general, there is no country in Europe in which corporation laws are so little oppressive. In France the duration of apprenticeships is different in different towns, and in different trades. In Paris, 5 years are the term required in a great number; and before any person can be qualified to exercise the trade as a master, he must, in many of them, serve 5 years more as a journeyman. During this latter time he is called the companion of his master, and the term itself is called his companionship. The institution of long apprenticeships, says Dr. Smith, can give no security that insufficient workmanship shall not frequently be exposed to sale; nor has it any tendency to form young people to industry. Apprenticeships were altogether unknown to the ancients: the Roman law is perfectly silent with regard to them. There is no Greek or Latin word which expresses the

idea we now annex to the word apprentice.

Long apprenticeships are altogether unnecessary. The arts, which are much superior to common trades, such as those of making clocks and watches, contain no such mystery as to require a long course of instruction. In the common mechanic trades, the lessons of a few days might certainly be sufficient. The dexterity of hand, indeed, even in common trades, cannot be acquired without much practice and experience. But a young man would practise with much more diligence and attention, if from the beginning, he wrought as a journeyman, being paid in proportion to the little work which he could execute, and paying, in his turn, for the materials which he might sometimes spoil through aukwardness and inexperience. His education would generally in this way be more effectual, and always less tedious and expensive. The master, indeed, would be a loser; he would lose all the wages of the apprentice, which he now saves for seven years together. In the end, perhaps, the apprentice himself would be a loser: in a trade so easily learnt he would have more competitors; and his wages, when he came to be a complete workman, would be much less than at present. The same increase of competition would reduce the profits of the masters, as well as the wages of the workmen: the trades, the crafts, the mysteries would all be losers; but the public would be a gainer, the work of all artificers coming in this way much cheaper to market.

We cannot conclude this article better than by inserting an admirable paper on the subject of apprentice laws, drawn up, and printed for private circulation, by a gentleman of high legal authority, and member of parliament, entitled "A few Opinions of some great and good Men, and sound Lawyers, on the Apprentice Laws of Queen Elizabeth, applicable to the Æra of 1806-7."

Lord Mansfield, in his arguments on the case, Rennard and Chase, brewers. 1 Bur. Rep. p. 2, says, "It hath been well observed that this act (*viz.* 5 Eliz. chap. 4.) is,

1. A penal law.
2. It is a restraint on natural right.
3. It is contrary to the general right given by the common law of this kingdom.
4. The policy upon which this act was made, is from experience become doubtful. Bad and unskilful workmen are rarely prosecuted. This act was made early in the reign of Queen Elizabeth, when the great number of manufacturers, who took refuge in England after the Duke of Alva's prosecution, had brought trade and commerce with them, and enlarged our notions. The restraint introduced by this law was thought unfavourable; and the judges, by a liberal interpretation, have extended the qualification for exercising the trade much beyond the letter of it, and confined the penalty and prohibition to cases precisely within the express letter." Burn's Justice, vol. i. Art. Apprentices.

3d Modern Reports, p. 317. Judge Dolben, in delivering his opinion, said, that "No encouragement was ever given to prosecutions upon the statute 5 Eliz., and that it would be for the common good if it were repealed; for no greater punishment can be to the seller, than to expose to sale goods ill-wrought, for by such means he will never sell more."

2 Salk. 613. The Queen v. Maddox.—It was held by the court, "that upon indictments upon the statute of 5 Eliz. the following of a trade for seven years to be sufficient without any holding; this being a hard law." And so held in Lord Raymond, 738.

Burn's Justice.—"So detrimental was this statute thought, that by 15 Car. II. all persons spinning or making cloth of hemp or flax, or nets for fishing, or storin or cordage, might exercise those trades without serving apprenticeships. And so little did the legislature, at subsequent periods, think that any benefit was to be derived from the statute of 5 Eliz. or that manufactures were made better, or improved by this restraint; and the minds of men being more liberal, that trade should, as much as possible, be flung open; it is enacted, by 6 and 7 William III. that any apprentice discovering two persons guilty of coining, so as they are convicted, shall be deemed a freeman, and may exercise his trade as if he had served out his time."

And, in order still stronger to shew how little the legislature esteemed the seven years binding ameliorated manufactures, it is enacted, by 3 George III. cap. 8, that "All officers, marines, and soldiers, who have been employed in his Majesty's service, and not deserted, may exercise such trades as they are apt for, in any town or place."

So dangerous and fatal has been the evil of combinations and conspiracies among journeymen, that in particular instances, as in trades where many hands are required and very little skill, as dyeing, and such like,

the legislature have made express laws to give relief to masters. See 17 Geo. III. cap. 33.; which enables dyers, in Middlesex, Essex, Surrey, and Kent, to employ journeymen who have not served apprenticeships. And to such a pitch has this mischief in the West Riding of Yorkshire increased, by the conspiracies facilitated by the act of 5 Eliz. that it goes to the total annihilation of our staple manufactures, and every other trade which hopes for success not only by the home, but from foreign consumption. See the report from the committee of the House of Commons, on the woollen trade and manufacture of these kingdoms, made in the last session of parliament, 4th July 1806.

After stating the above, let us quote the words of the immortal Lord Chief Justice Coke on this point.—"That, at the common law, no man could be prohibited from working in any lawful trade; for the law abhors idleness, the mother of all evil—*Otium omnium vitiorum mater*—and especially in young men, who ought in their youth (which is their seed time) to learn lawful sciences and trades, which are profitable to the commonwealth, whereof they might reap the benefit in their old age: for 'idle in youth, poor in age'."

And therefore the common law abhors all monopolies, which prohibit any from working in any lawful trade. And that appears in 2 Hen. V. 5 b. A dyer was bound not to use the dyer's craft for two years: and there Judge Hall held, "that the bond was against the common law; and by G—d if the plaintiff was here, he should go to prison till he paid a fine to the king." And vide 7 Edw. III. 65 b. "And, if he who takes upon himself to work is unskilful, his ignorance is a sufficient punishment to him, for *imperitia est maxima mecanicorum pœna; et quilibet quærit in quâlibet arte peritos*:—which is, 'that want of skill is the greatest punishment of mechanics; for every body will employ those that are the best skilled in their business.' And, if any one takes upon himself to work, and spoils it, an action on the case lies against him."

Having observed thus much, and stated the opinions of two such great men as Lord Coke and Lord Mansfield, we can only add one dixit of Lord Coke's, that, "acts of parliament which are made against the freedom of trade, merchandizing, handicrafts, and mysteries, never live long." 4th Inst. 31.

It is to be observed, that this very great check upon trade, by not being able to employ any hands that are able to perform the work required, and especially in those trades which are so easily learnt in a very short space of time, greatly enhances the prices of all articles, and that a time when population is daily increasing, and the demand proportionably increasing. And this statute is not only a restraining statute, but also an enabling statute, as it empowers the workmen to enter into combinations against their masters, and to dictate their own terms, encouraging vice, idleness, and drunkenness; demands being made on the masters for an increase of wages; those demands supported by dangerous combinations and conspiracies, and extorted by threats. And such increase, when obtained, not applied for the wholesome purpose of supporting themselves and their families, but to that very destructive purpose, ruinous to their families, and highly detrimental to the public at large, the enabling of the parties to spend more days of the week in idleness, drunkenness, vice, and immorality. In many manufactures, so much money is extorted by the journeymen, by means of these combinations, from their employers, that the journeymen will work but three days in the week; so that 600 are necessarily required to do the work that 300 might do.

Until these laws, restricting the binding of apprentices, are repealed, all laws made for the prevention of combinations among workmen can be of no avail, and will remain a dead letter in the law books: as in this free country, (however that freedom may be limited as to the checking of masters binding apprentices), no law on this point can be so worded, that the art, wickedness, and ingenuity of men, will not contrive to defeat. A bad and absurd law is made, *viz.* the "Apprentice Act," which, by the extension of trade, is found detrimental to trade; and then, to do away the mischiefs of that law, another absurd law is made, *viz.* the law to prevent combination, —so that mischief is heaped upon mischief, and absurdity upon absurdity. Trade should be as free as the air we breathe. This is an axiom, the truth of which every day convinces us.

APPROACHES, in fortification, the works thrown up by the besiegers, in order to get nearer a fortress, without being exposed to the enemy's cannon: such, in a more particular manner, are the trenches, which should be connected by parallels, or lines of communication.

This is the most difficult part of a siege, and where most lives are lost. The ground is disputed inch by inch, and it is of the utmost importance to make the approaches with great caution, and to secure them as much as possible.

The besieged frequently make counter-approaches, to interrupt and defeat the enemy's approaches.

APPROPRIATION, the annexing a benefice to the proper and perpetual use of a religious house, bishopric, college, &c. Where the king is patron, he may make appropriations himself; but in other cases, after obtaining his licence in chancery, the consent of the ordinary, patron, and incumbent is requisite. Appropriations cannot be assigned over, but those to whom they are granted may make leases of the profits. There are in England 2845 impropriations.

APPROVER, in law, a person, who being indicted of treason or felony, for which he is not in prison, confesses the indictment; and being sworn to reveal all the treasons and felonies he knows, enters before the coroner his appeal against all his partners in the crime. All persons may be approvers, except peers of the realm, persons attainted of treason or felony, or out-lawed, infants, women, persons *non compos*, or in holy orders.

APPROXIMATION, in arithmetic and algebra, the coming nearer and nearer to a root, or other quantity sought, without expecting to be ever able to find it exactly. There are several methods for doing this, to be found in mathematical books, being nothing but infinitely converging series, some approaching quicker, others slower towards the truth.

By such an approximation the value of a quantity may be found, though not to the utmost degree of exactness, yet sufficiently so for practice. Thus $\sqrt{2} = 1.41421356$, &c. = the approximating series $1 + \frac{4}{10} + \frac{1}{100} + \frac{4}{1000} + \frac{2}{10000} +$, &c. or supposing $x = \frac{1}{10}$, equal to the series $1 \times \frac{4}{x} + \frac{1}{x^2} + \frac{4}{x^3} + \frac{2}{x^4} +$, &c. $= 1 + 4x^{-1} + x^{-2} + 4x^{-3} + 2x^{-4} +$, &c.

Again, supposing $a^2 + b$ to be a non-quadrate number, and $a^3 + b$ to be a non-cubic one; then will $\sqrt{a^2 + b} = a + \frac{ab}{2a^2 + \frac{1}{2}b}$, and $\sqrt[3]{a^3 + b} = a + \frac{ab}{3a^3 + b} = \frac{1}{2}a + \sqrt{\frac{1}{4}a^3 + \frac{b}{3a}}$ nearly.

There is a general method of investigating the value of such series, for which see SERIES.

APPULSE, in astronomy, the approach of a planet towards a conjunction with the sun, or any of the fixed stars. The appulses of the planets to the fixed stars have always been of great use to astronomers in order to fix the places of the former. The ancients wanting an easy method of comparing the planets with the ecliptic, which is not visible, had scarce any other way of fixing their situations, but by observing their tract among the fixed stars, and remarking their appulses to some of those visible points. Dr. Halley has published a method of determining the places of the planets, by observing their near appulses to the fixed stars.

APPURTENANCES, in common law, signify things corporeal and incorporeal, that appertain to another thing as principal; as hamlets to a manor, and common of pasture and fishery. Things must agree in nature and quality to be appurtenant, as a turbary, or a seat in a church, to a house.

APRICOT, in botany, a species of prunus, with rosaceous flowers, and a delicious fleshy fruit, of a roundish figure. See PRUNUS.

APRON, in gunnery, the piece of lead which covers the touch hole of a cannon.

The dimensions of aprons are as follow; *viz.* for 42, 32, and 24 pounders, 15 inches by 13; for 18, 12, and 9 pounders, 12 inches by 10; and for cannon of less calibre, 10 inches by 8. They are tied by two strings of white marline.

APSIS, in astronomy, a term used indifferently for either of the two points of a planet's orbit, where it is at the greatest or least distance from the sun or earth. Hence the line connecting these points, is called the line of the apsides.

APTENODYTES, in ornithology *penguin*, a genus of the order Anseres. The bill is straight, rather compressed, and sharp along the edges; the upper mandible is obliquely sulcated, lengthwise; feet palmated, shackled; wings fin-shaped, and without quill-feathers; feet fettered, four-toed. This genus resembles the alca in colour, food, stupidity, eggs, nest, position of legs behind the equilibrium, and consequent erect posture. They are totally unfit for flight, but swim dextrously; nostrils linear, hid in the groove of the bill, palate as well as the tongue beset with a few rows of conic, retroflected, stiff papillæ; wings covered with a strong broad membrane; tail

short, wedged, the feathers very rigid. There are nine species according to Latham, but Gmelin enumerates eleven.

This genus of birds seems to hold the same place in the southern parts of the world as the awks do in the northern, and are by no means to be confounded the one with the other, however authors may differ in opinion in respect to this matter. The penguin is seen only in the temperate and frigid zones, on that side of the equator which it frequents; and the same is observed of the awk in the opposite latitudes; and neither of the genera has yet been observed within the tropics. The awk has true wings and quills, though small; the penguin mere fins only, instead of wings. This last has four toes on each foot; but the former only three. The penguin, while swimming, sinks quite above the breast; the head and neck only appearing out of the water, rowing itself along with its finny wings, as with oars; while the awk, in common with most other birds, swims on the surface. Several other circumstances peculiar to each might be mentioned; but we trust the above will prove fully sufficient to characterize this genus. The bodies of the penguin tribe are commonly so well and closely covered with feathers, that no wet can penetrate; and as they are in general excessively fat, these circumstances united secure them from the cold. They have often been found above seven hundred leagues from land; and frequently on the mountains of ice, on which they seem to ascend without difficulty, as the soles of their feet are very rough, and suited to the purpose.

Aptenodytes antarctica, is full 25 inches long, and weighs eleven or twelve pounds: it inhabits the south sea from 48° to the antarctic circle, and is frequently found on the ice mountains and islands on which it ascends. It is a numerous tribe; and they were found in great plenty in the Isle of Desolation.

The black-footed penguin is found in the neighbourhood of the Cape of Good Hope, but particularly in Robbean or Penguin Isles, near Saldanic Bay. Like all the genus, this is an excellent swimmer and diver; but hops and flutters in a strange and aukward manner on the land, and, if hurried, stumbles perpetually; and frequently runs for some distance like a quadruped, making use of the wings instead of legs, till it can recover its upright posture; crying out at the same time like a goose, but in a much hoarser voice. It is said to clamber some way up the rocks in order to make a nest, in doing which it has been observed to be assisted with the bill. The eggs are two, and esteemed at the Cape very delicious.

Aptinodytes chrysocome. This beautiful species measures twenty-three inches in length. The bill is three inches long; the colour of it red, with a dark furrow running along on each side to the tip; the upper mandible is curved at the end, the under obtuse; irides of a dull red; the head, neck, back, and sides, are black; over each eye a stripe of pale yellow feathers, which lengthens into a crest behind, of near four inches in length; the feathers on each side of the head, above this stripe, are longer than the rest, and stand upward, while those of the crest are decumbent, but can be erected on each side at will; the wings, or rather fins, are black on the outside, edged with white; on the inside white; the breast, and all the under parts, white; the legs are orange; claws dusky. The female has a streak of pale yellow over the eye, but it is not prolonged into a crest behind as in the male. Inhabits Falkland's Islands, and was likewise met with in Kirguelin's Land, or Isle of Desolation, as well as at Van Diemen's Land, and New Holland, particularly in Adventure Bay. Are called Hopping Penguins, and Jumping Jacks, from their action of leaping quite out of the water, on meeting with the least obstacle, for three or four feet at least; and indeed, without any seeming cause, do the same frequently, appearing chiefly to advance by that means. This species seems to have a greater air of liveliness in its countenance than others, yet is in fact a very stupid bird, so much so as to suffer itself to be knocked on the head with a stick, when on land. When angered, it erects its crest in a beautiful manner. These birds make their nests among those of the pelican tribe, living in tolerable harmony with them; and lay seldom more than one egg, which is white, and larger than that of a duck. They are mostly seen by themselves, seldom mixing with other penguins, and often met with in great numbers on the outer shores, where they have been bred. Are frequently so regardless as to suffer themselves to be taken by the hand. The females of this species lay their eggs in burrows, which they easily form of themselves with their bills, throwing out the dirt with their feet. In these holes the eggs are deposited on the bare earth. The general time of sitting is

in October; but some of the species, especially in the colder parts, do not sit till December, or even January. How long they sit is not known.

Aptenodytes magellanica, inhabits the Straits of Magellan, Staaten Land, Terra del Fuego, and the Falkland Isles; is a very numerous species, and is often seen by thousands, retiring by night to the highest parts of the islands. Its voice is not much unlike the braying of an ass. It is not a timid bird, for it will scarcely get out of the way of any one; but will rather attack and bite a person by the legs. They were killed by hundreds by the crews of Captain Cooke's expedition, and were found not unpalatable food. They often mix with the sea-wolves, among the rushes, burrowing in holes like a fox. When they swim, only the neck and shoulders appear out of the water, and they advance with such agility, that no fish seems able to follow them; if they meet with any obstacle, they leap four or five feet out of the water; and dipping into it again, continue their route. It is supposed by Latham that Penrose alludes to this species, of which he says, the chief curiosity is the laying their eggs; this they do in collective bodies, resorting in incredible numbers, to certain spots, which their long residence has freed from grass, and to which were given the name of towns. The eggs are rather larger than those of a goose, and are laid in pairs. They lay some time in November, driving away the albatrosses, which have hatched their young in turn before them.

Aptenodytes patachonica. This is the largest of the genus yet known, being four feet three inches in length; and stands erect at least three feet; the weight forty pounds. This species was first met with in Falkland Islands, and has also been seen in Kerguelen's Land, New Georgia, and New Guinea. M. Bougainville caught one, which soon became so tame as to follow and know the person who had care of it; it fed on flesh, fish, and bread, but after a time grew lean, pined away, and died. The chief food, when at large, is thought to be fish; the remains of which, as well as crabs, shell-fish, and molluscæ, were found in the stomach. This species is the fattest of the tribe; most so in January, when they moult. Supposed to lay and sit in October. Are met with in the most deserted places. Their flesh is black, though not very unpalatable. This has been considered as a solitary species, but has now and then been met with in considerable flocks. They are found in the same places as the papuan penguins, and not unfrequently mixed with them; but in general shew a disposition of associating with their own species. See Plate III. Aves. fig. 6.

APTERA, in the Linnæan system of zoology, the seventh and last order of Insects, the distinguishing characteristic of which is, that the insects comprehended in it have no wings. Of this order there are three divisions. In A. the insects are distinguished by having six legs; head distinct from the thorax: there are five genera; *viz.* the

Lepisma,	Pulex,
Pediculus,	Termes.
Podura,	

In the division B., the insects have from 8 to 14 legs; head and thorax united: of these there are eight genera; *viz.* the

Acarus,	Monoculus,
Aranea,	Oniscus,
Cancer,	Phalangium,
Hydrachna,	Scorpio.

In the division C., the legs are numerous; head distinct from the thorax: of which there are two species; *viz.* the

Julus, and
Scolopendra.

This order comprehends all kinds of spiders, the lice of different animals, scorpions, and crabs. Upon these we may make a few general observations. The nets spread out by spiders to catch their prey, are composed of similar materials to the silk of the silk-worm, and are spun from the animal's body nearly in the same way. The cobwebs of the gossamer are frequently seen floating in the air in a sunny day, and are sometimes so abundant as to fall in showers. Each of these has been compared to a balloon transporting the little aeronaut that formed it, by means of its specific lightness. This species of spider attaching its first formed thread to the leaf or branch of a tree, by dropping to a certain distance, lengthens it, then climbs up the thread, and, dropping again, draws out another, and so on, till a sufficient quantity of this silk is formed to buoy the spider up in the air. He then separates the whole from the leaf, and running down to his seat at the bottom, trusts himself and his balloon to the mercy of the wind. By this method, these animals are transported from tree to tree, and from wood to wood, in search of food. The cobwebs that are spread over the surface of

the grass, and that offer so beautiful an object to the eye early in the summer's morning, through the brilliancy of the dew-drops formed and suspended on their silken threads, and the reflexion of the sun's rays from each, are the work of another species of spiders.

The different kinds of lice are exceedingly numerous, almost every kind of animal having its particular sort of vermin. They are all carnivorous, or perhaps rather sanguivorous insects, living on the blood of other animals. Their eggs are all nits. The Scorpio genus abound in hot climates, and are troublesome in neglected places, and where cleanliness is not attended to. The crab tribes cast their shells every year, and are then in a soft, helpless state, unable to make resistance, and therefore at that time become the prey of many kinds of fish. Their shells afford a principal constituent in the formation of chalk-beds, and beds of marl, which are formed at the bottom of the sea. Specimens of entire shells are frequently met with in chalk-pits which are now many miles inland; and there is little doubt, that in a comminated state, they form a principal ingredient in most calcareous earth. Under each genus will be found an account of a few of the more remarkable species. See Acarus, Aranea, Cancer, Scorpio, &c.

APUS, in astronomy, a constellation of the southern hemisphere, placed near the pole, between the Triangulum Australe, and the Chameleon, supposed to represent the bird of paradise. There are four stars of the sixth, three of the fifth, and four of the fourth magnitude, in the constellation Apus. Dr. Halley, in 1677, observed the longitude and latitude of the stars in Apus, which Hevelius in his prodromus reduced with some alteration to the year 1700. P. Noel has also given the places of these stars, with their right ascensions and declinations for the year 1687, but his observations differ widely from those of Dr. Halley. Hevelius has represented the figure of Apus, and its stars, in his Firmamentum Sobiescianum, according to Halley's account; Noel has done the like according to his own account. Wolfius, with what justice we will not pretend to say, gives the preference to this last.

AQUA *fortis*. Another name for Nitric Acid, which see. This name is applied to denote the common nitric acid, used by workmen, which often contains a slight portion of muriatic acid. See Chemistry.

Aqua *regia*, another name for the nitro muriatic acid. See Muriatic Acid.

AQUÆDUCT, *a conduit of water*, in architecture and hydraulics, is a construction of stone or timber, built on an uneven ground, to preserve the level of water, and convey it by a canal, from one place to another. Some of these aquæducts are visible, and others subterraneous. Those of the former sort are constructed at a great height, across vallies and marshes, and supported by piers and ranges of arches. The latter are formed by piercing the mountains. and constructing them below the surface of the earth. They are built of stone, brick, &c. and covered above with vaulted roofs or flat stones, serving to shelter the water from the sun and rain. Of these aquæducts, some are double, and others triple; that is, supported on two or three ranges of arches. Of the latter kind are the Pont-du-gard, in Languedoc, supposed to have been built by the Romans to carry water to the city of Nismes; that of Constantinople, and that which, according to Procopius, was constructed by Cosroes, King of Persia, near Petra, in Mingrelia, and which had three conduits in the same direction, each elevated above the other. Some of these aquæducts were paved, and others conveyed the water through a natural channel of clay; and it was frequently conducted by pipes of lead into reservoirs of the same metal, or into troughs of hewn stone. Aquæducts of every kind were reckoned among the wonders of ancient Rome; their great number, and the immense expense of bringing water 30, 40, or 60, and even 100 miles, either upon continued arches, or by means of other works, when it was necessary to penetrate mountains and rocks, may well astonish us. If, we consider the incredible quantity of water brought to Rome for the uses of the public, for fountains, baths, fish-ponds, private-houses, gardens and country-seats; if we represent to ourselves the arches constructed at a great expense, and carried on through a long distance, mountains levelled, rocks cut through, and vallies filled up, it must be acknowledged that there is nothing in the whole world more wonderful. For 440 years, the Romans contented themselves with the waters of the Tiber, and of the wells and fountains in the city and its neighbourhood. But when the number of houses and inhabitants was considerably augmented, they were obliged to bring water from remote places by means of aquæducts.

Even Tiberius, Claudius, Caligula, and Caracalla, though in other respects not of the best character, took care of the city in this useful article. There are still to be seen in the country about Rome wonderful remains of the ancient aquæducts, some elevated above the ground by arches continued and raised one above the other, and others subterraneous, passing through rocks; such is that seen at Vicovaro, beyond Tivoli, in which a canal pierces a rock to the extent of more than a mile, and about five feet deep and four broad. At certain distances vents were provided, so that the water which was accidentally obstructed in its passage, might be discharged, till its ordinary passage was cleared; and in the canal of the aquæduct itself there were cavities, into which the water was precipitated, and where it remained till its mud was deposited; and ponds in which it might purify itself. In the construction of these aquæducts, there was a considerable variety: that called the Aqua Marcia had an arch of sixteen feet in diameter; it was constructed of three kinds of stone, and was formed with two canals, one above the other. The most elevated was supplied by the waters of the Tiverone, Anionovus, and the lowest by the Claudian water. The entire edifice was 70 Roman feet high. The arch of the aquæduct which brought to Rome the Claudian water, was constructed of beautiful hewn stone. This is represented by Pliny as the most beautiful of all that had been built for the use of Rome. It conveyed the water, through a vaulted canal, through the distance of 40 miles, and was so high that it supplied all the hills of the city. According to him, and the computation of Budæus, the charge of this work amounted to 1,385,500 crowns. This aquæduct was begun by Caligula, and finished by Claudius, who brought its waters from two springs, called Cæruleus and Curtius. Vespasian, Titus, Marcus Aurelius, and Antoninus Pius, repaired and extended it; it is now called Aqua Felice. The three chief aquæducts now in being are those of the Aquà Virginea, Aqua Felice, and Aqua Paulina. The first was repaired by Pope Paul IV. The second was constructed by Pope Sixtus V. and is called from the name which he assumed before he was exalted to the Papal throne. It proceeds from Palæstrina at the distance of twenty-two miles, and discharges itself at the Fontana di Termini, which was also built at his expense, and consists of three arches, supported by four Corinthian pillars, and the water gushes out through three large apertures. Over the middle arch stands a beautiful statue of Moses striking the rock with his rod; over another arch is a basso-relievo of Aaron leading the people to the miraculous springs in the wilderness; and the third exhibits Gideon trying his soldiers by their drinking water. Round it are four lions, two of marble, and the other two of oriental granite, said to be brought thither from a temple of Serapis. All the four lions eject water; and on the front is an inscription, importing that this aquæduct was begun in the first and completed in the third year of the Pontificate of Sixtus V. 1588. The third was repaired by Pope Paul V. in the year 1612. This divides itself into two principal channels, one of which supplies Mount Janiculus, and the other the Vatican and its neighbourhood. It is conveyed through the distance of thirty miles, from the district of Bracciano, and three of its five streams are not inferior to small rivers, and sufficient to turn a mill. The famous aquæducts of Constantinople, about six miles from the village of Belgrade, were built by Valentinian the First, Clearchus, being præfect, and afterwards repaired by Solyman the Magnificent, who exempted twelve adjacent Greek villages from the customary tribute of the empire, in consideration of their keeping these aquæducts in repair. Of these the most remarkable are three large and lofty fabrics, built over so many vallies betwixt the adjoining hills, of which the longest has many but less arches, and may possibly be the entire work of Solyman. The other two have the appearance of a more ancient and regular architecture, consisting of two rows of arches one over the other; and those of the second were enclosed by pillars cut through the middle, so as to render the fabric both passable like a bridge, and useful for the conveyance of water. The more considerable of these two consists of only four large arches, each twenty yards long, and somewhat above twenty high, supported by octangular pillars of about 56 yards in circumference towards the bottom. For an inquiry into the nature and construction of the aquæducts of the Romans, see Governor Pownall's Notices and Descriptions of Antiquities of the Provincia Romana of Gaul, 4to. 1788. The aquæduct built by Lewis XIV. near Maintinon, for carrying the river Bure to Versailles, is perhaps the greatest now in the world. It is 7000 fathoms long,

and its elevation 2560 fathoms; containing 242 arcades.

AQUARIUS, in astronomy, a constellation which makes the eleventh sign in the zodiac, marked thus, ♒. It consists of 45 stars in Ptolomy's catalogue, of 41 in Tycho's, and in the Britannic catalogue, of 108. It was called Aquarius, or the Water-bearer, as some say, because, during the sun's motion through this sign, it is generally rainy weather.

AQUARTIA, in botany, a genus of the Tetrandia Monogynia class and order. Calyx campanulate; corol wheel-shaped, with linear segments; berry many-seeded. There are two species.

AQUATIC, in natural history, an appellation given to such things as live or grow in the water: thus we say, aquatic animals, aquatic plants, &c.

AQUEOUS *humour*, or the watery humour of the eye, it is the first and outermost, and that which is less dense than either the vitreous or crystalline. It is transparent and colourless like water, and fills up the space that lies between the cornea and the crystalline humour. See OPTICS.

AQUILA, the *eagle*, in ornithology. See FALCO.

AQUILA, in astronomy, a constellation of the northern hemisphere, consisting of 15 stars in Ptolemy's catalogue, 19 in Tycho Brahe's, 42 in that of Hevelius, and 71 in Flamstead's; the principal star being Lucida Aquila, and is between the first and second magnitude.

AQUILARIA, in botany, a large tree affecting a lofty situation. Class Decandria Monogynia; cal. perianth one-leafed, permanent; tube bell-shaped; limb five-cleft; clefts ovate, acute, flat, spreading; cor. none; nectary one-leafed, pitcher-shaped, of the length of the tube of the calyx, half five-cleft; clefts bifid, obtuse; stam. filaments ten, alternating with the clefts of the nectary; anthers oblong, versatile; pist. germ ovate, superior; style, none; stigma, simple; per. capsule on a very short pedicle, obovate, woody, two-celled, two-valved, with the partition contrary, and bipartite; seeds solitary, oblong. There is but one species, Aquilaria ovata; leaves alternate, ovate, mucronate. This is a large tree covered with greyish bark. Its leaves are entire, smooth, veined, about eight inches long, and stand on short hairy footstalks. The flowers terminate the branches, on many-flowered peduncles. A native of the mountains of Malacca and Cochin-China. The wood of this tree has been long used as a perfume; and was formerly an article of the materia medica, under the name of agallochum, lignum aloes, or aloes wood. This wood in its natural state is white and inodorous. That which possesses the peculiar aroma for which it is valued, is supposed to be the consequence of a diseased process in the tree, causing the oleaginous particles to stagnate and concrete into a resin in the inner parts of the trunk and branches, by which the natural appearance of the wood is altered, so as to become of a darker colour, and of a fragrant smell. At length the tree dies, and when splitten, the resinous part is taken out. The perfumes which this wood affords are highly esteemed by the oriental nations; and from the bark of the tree is made the common paper which the Cochin-Chinese use for writing; in the same manner the Japanese make use of the bark of a species of mulberry (morus papyrifera). This perfume is said to be useful in vertigo and palsy: given in the form of powder, it is recommended to restrain vomitings and alvine fluxes. To us, however, it seems to contain little else than that camphoraceous matter common to many other vegetable substances. From its bitter taste it has the name of aloes, although no otherwise allied to it.

AQUILEGIA, *columbine*, in botany, a genus of the Polyandria Pentagynia class of plants, having no calyx; the corolla consists of five plane, patent, equal petals, of a lancelate, ovate figure; the nectaria are five in number; they are equal, and stand alternately with the petals; the fruit consists of five straight, parallel, cylindric, accuminated capsules, each of which consists of a single valve. The seeds are numerous, oval, carinated, and adhere to the suture. There are five species.

ARA, in astronomy, a southern constellation, consisting of eight stars.

ARABIS, in botany, *wall-cross*, a genus of the Tetradynamia Siliquosa class of plants, the calyx of which is a deciduous perianthium, consisting of four ovato-oblong, acute, gibbous, concave leaves; the corolla consists of four oval, patent, cruciform petals; the fruit is a very long compressed pod, containing several roundish compressed seeds. There are twenty-one species.

ARACHIS, in botany, *ground-nut*, a genus of the Diadelphia Decandria class of plants, the flower of which is papilionaceous,

and consists of three petals; and its fruit is an oblong unilocular pod, contracted in the middle, and containing two oblong, obtuse, and gibbous seeds. There is but one species, found in the Indies, a tree, stem herbaceous, hairy, procumbent. The branches trail on the ground, and the germ, after flowering, thrusts itself under ground, where the food is formed and ripened.

ARACHNOIDES, in zoology, a name given to those echini marini, or sea-hedgehogs, which are of a circular form, but variously indented at the edges. See ECHINUS.

ARALIA, *berry-bearing angelica*, in botany, a genus of the Pentandria Pentagynia class of plants, the flowers of which are collected into an umbel, of a globose figure, with a very small involucrum; the perianthium is very small, divided into five parts, and placed on the germen; the corolla consists of five, ovato-acute, sessile, reflex petals; the fruit is a roundish, coronated, striated berry; having five cells; the seeds are single, hard, and oblong. There are four divisions, *viz.* A. leaves entire; B. leaves lobed; C. leaves in finger-like divisions; D. leaves decompound, and more than decompound. In the first there are three species; in the second one; in the third two; and in the fourth four.

ARANEA, in natural history, the *spider*, a genus of insects of the order Aptera. Gen. char. legs eight; eyes eight, sometimes six; mouth furnished with two hooks, or holders; feelers two, jointed, the tips of which in the male distinguish the sex; abdomen terminated by papillæ, or teats, through which the insect draws the thread.

One of the largest of the European spiders is the Aranea diadema of Linnæus, which is extremely common in our own country, and is chiefly seen during the autumnal season in gardens, &c. The body of this species, when full grown, is not much inferior in size to a small hazel nut: the abdomen is beautifully marked by a longitudinal series of round, or drop-shaped milk-white spots, crossed by others of similar appearance, so as to represent, in some degree, the pattern of a small diadem. This spider, in the months of September and October, forms, in some convenient spot or shelter, a large round close, or thick web of yellow silk, in which it deposits its eggs, guarding the round web with a secondary one of a looser texture. The young are hatched in the ensuing May, the parent insects dying towards the close of autumn. The Aranea diadema being one of the largest of the common spiders, serves to exemplify some of the principal characters of the genus in a clearer manner than most others. At the tip of the abdomen are placed five papillæ or teats, through which the insect draws its thread; and as each of these papillæ is furnished with a vast number of foramina or outlets, disposed over its whole surface, it follows that what we commonly term a spider's thread, is in reality formed of a collection of a great many distinct ones; the animal possessing the power of drawing out more or fewer at pleasure; and if it should draw from all the foramina at once, the thread might consist of many hundred distinct filaments. The eyes, which are situated on the upper part or front of the thorax, are eight in number, placed at a small distance from each other, and having the appearance of the stemmata in the generality of insects. The fangs or piercers, with which the animal wounds its prey, are strong, curved, sharp-pointed, and each furnished on the inside, near the tip, with a small oblong hole or slit, through which is evacuated a poisonous fluid into the wound made by the point itself, these organs operating in miniature on the same principle with the fangs in poisonous serpents. The feet are of a highly curious structure; the two claws with which each is terminated being furnished on its under side with several parallel processes resembling the teeth of a comb, and enabling the animal to dispose and manage with the utmost facility the disposition of the threads in its web, &c.

Aranea tarantula, or Tarantula spider, of which so many idle recitals have been detailed in the works of the learned, and which, even to this day, continues in some countries to exercise the faith and ignorance of the vulgar, is a native of the warmer parts of Italy and other warm European regions, and is generally found in dry and sunny plains. It is the largest of all the European spiders, but the extraordinary symptoms supposed to ensue from the bite of this insect, as well as their supposed cure by the power of music alone, are entirely fabulous, and are now sufficiently exploded among all rational philosophers. The gigantic Aranea avicularia, or Bird-catching spider, is not uncommon in many parts of the East Indies and South America, where it resides among trees; frequently seizing on small birds, which it destroys by wounding with its fangs, and afterwards sucking their blood; during the early part of the

last century a project was entertained by a French gentleman, Monsieur Bon of Montpelier, of instituting a manufacture of spiders' silk, and the Royal Academy, to which the scheme was proposed, appointed the ingenious Reaumur to repeat the experiments of Monsieur Bon, in order to ascertain how far the proposed plan might be carried; but, after making the proper trials, Mr. Reaumur found it to be impracticable, on account of the natural disposition of these animals, which is such as will by no means admit of their living peaceably together in large numbers. Mr. Reaumur also computed that 663522 spiders would scarcely furnish a single pound of silk. Monsieur Bon, however, the first projector, carried his experiments so far as to obtain two or three pair of stockings and gloves of this silk; which were of an elegant grey colour, and were presented, as samples, to the Royal Academy. It must be observed that in this manufacture it is the silk of the egg-bags alone that can be used, being far stronger than that of the webs. Monsieur Bon collected twelve or thirteen ounces of these, and having caused them to be well cleared of dust, by properly beating with sticks, he washed them perfectly clean in warm water. After this they were laid to steep, in a large vessel, with soap, saltpetre, and gum arabic. The whole was left to boil over a gentle fire for three hours, and were afterwards again washed to get out the soap; then laid to dry for some days, after which they were carded, but with much smaller cards than ordinary. The silk is easily spun into a fine and strong thread: the difficulty being only to collect the silk-bags in sufficient quantity. There remains one more particularity in the history of spiders, *viz.* the power of flight. It is principally in the autumnal season that these diminutive adventurers ascend the air, and contribute to fill it with that infinity of floating cobwebs which are so peculiarly conspicuous at that period of the year. When inclined to make these aerial excursions, the spider ascends some slight eminence, as the top of a wall, or the branch of a tree; and turning itself with its head towards the wind, ejaculates several threads, and rising from its station, commits itself to the gale, and is thus carried far beyond the height of the loftiest towers, and enjoys the pleasure of a clearer atmosphere. During their flight it is probable that spiders employ themselves in catching such minute winged insects as may happen to occur in their progress; and when satisfied with their journey and their prey, they suffer themselves to fall, by contracting their limbs, and gradually disengaging themselves from the thread which supports them. See Plate I. Entomology, fig. 7 and 8.

ARAUCARIA, in botany, a genus of the Dioecia Monadelphia class and order. Male, calyx scales of an ament, terminated by a leafet; no corol; antheræ 10 to 12, without filaments. Female, calyx an ament with many germs; no corol; stigma two-valved, unequal; seeds numerous, in a roundish cone.

ARBITER, in civil law, a judge nominated by the magistrate, or chosen voluntarily by two parties, in order to decide their differences according to law.

The civilians make this difference between arbiter and arbitrator; though both ground their power on the compromise of the parties, yet their liberty is different, for an arbiter is to judge according to the usages of the law, but the arbitrator is permitted to use his own discretion, and accommodate the difference in the manner that appears to him most just and equitable.

ARBITRATION, a power given by two or more contending parties to some person or persons to determine the dispute between them: if the two do not agree it is usual to add that another person be called as umpire, to whose sole judgment it is then referred. The submission to arbitration is the authority given by the parties in controversy to the arbitrators, to determine and end their grievances; and this being a contract or agreement, must not be strictly taken, but largely, according to the intent of the parties submitted. There are five things incident to an arbitration: 1. Matter of controversy. 2. Submission. 3. Parties to the submission. 4. Arbitrators. 5. Giving up the arbitration. Matters relating to a freehold, debts due on bond, and criminal offences are not to be arbitrated.

ARBITRATOR, a private extraordinary judge, chosen by the mutual consent of parties, to determine controversies between them. Arbitrators are to award what is equal between both parties, and the performance must be lawful and possible. An action of debt may be brought for money adjudged to be paid by arbitrators.

ARBOR *Dianæ*. See CHEMISTRY.

ARBOR *vitæ*. See THUJA.

ARBOR, in mechanics, the principal part of a machine which serves to sustain the rest; also the axis or spindle on which a

machine turns, as the arbor of a crane, windmill, &c.

ARBUTUS, the *strawberry-tree*, in botany, a genus of the Decandria Monogynia class of plants, the calyx of which is a very small, obtuse, permanent perianthium, divided into five segments; the corolla consists of a single oval petal, divided also into five segments; the fruit is a roundish berry, containing five cells, and small osseous seeds. There are ten species.

ARC *concentric*, is that which has the same centre, with another arc.

ARC *diurnal*, that part of a circle described by a heavenly body, between its rising and setting; as the nocturnal arc is that described between its setting and rising: both these together are always equal.

ARCS *equal*, those which contain the same number of degrees, and whose radii are equal.

ARCA, in conchology, a genus of Bivalves, the animal of which is supposed to be a tethys, the valves are equal, and the hinge beset with numerous sharp teeth inserted between each other.

ARCA, in natural history, a genus of worms of the order Testacea; animal a tethys; shell bivalve, equivalve; hinge with numerous sharp teeth, alternately inserted between each other. There are, according to Gmelin, 43 species: but they are separated into four divisions, *viz.* A. margin very entire, beaks recurved; B. margin entire, beaks inflected; C. margin crenate, beaks recurved; D. margin crenate, beaks inflected: of the latter we shall notice A. nucleus; shell obliquely ovate, smoothish, with a triangular hinge; inhabits European seas, and is sometimes found fossile, the size of a hazel nut, covered with an olivaceous skin, under which it is white, within silvery; shell unequally triangular, with very fine perpendicular striæ, crossed by a few arched transverse ones; depression behind the beak, heart-shaped.

ARCH, or ARC, in geometry, any part of the circumference of a circle, or curved line, lying from one point to another, by which the quantity of the whole circle or line, or some other thing sought after, may be gathered.

All angles are measured by arcs. For this purpose an arc is described having its centre in the point or vertex of the angle: and as every circle is supposed to be divided into 360°, an arc is estimated according to the number of degrees which it contains. Thus an arc is said to be of 30, 50, or 100 degrees, &c.

ARCH, in architecture, a concave building, with a mold bent in the form of a curve, erected to support some structure. Arches are either circular, elliptical, or straight, as they are improperly called by workmen. Circular arches are also of three kinds: 1. Semicircular, which have their centre in the middle of a line drawn betwixt the feet of the arch. 2. Scheme or skene, which are less than a semicircle, containing some 90, and some 70 degrees. 3. Arches of the third and fourth point, consisting of two arches of a circle meeting in an angle at the top, being drawn from the division of a chord into three or more parts at pleasure.

Elliptical arches consist of a semi-ellipsis, and have commonly a key-stone and imposts: they are usually described by workmen on three centres.

Straight arches are those used over doors and windows, having plain straight edges, both upper and under, which are parallel, but both the ends and joints point towards a center.

The term arch is peculiarly used for the space between two piers of a bridge, intended for the passage of water, vessels, &c.

ARCH *of equilibration*, is that which is in equilibrium in all its parts, having no tendency to break in any one part more than in another; and which is, therefore, safer and stronger than any other figure. No other arch than this can admit of a horizontal line at top: it is of a form both graceful and convenient, as it may be made higher or lower at pleasure, with the same span. All other arches require extrados that are curved, more or less, either upwards or downwards; of these, the elliptical arch approaches the nearest to that of equilibration for strength and convenience, and it is the best form for most bridges, as it can be made of any height to the same span, its haunches being at the same time sufficiently elevated above the water, even when it is very flat at top. Elliptical arches also appear bolder and lighter, are more uniformly strong, and are cheaper than most others, as they require less materials and labour. Of the other curves, the cycloidal arch is next in quality to the elliptical one, and lastly the circle.

ARCHANGEL, in botany. See LAMIUM.

ARCHES, or *Court of* ARCHES, the supreme court belonging to the Archbishop

of Canterbury, to which appeals lie from all the inferior courts within his province.

ARCHETYPE, the first model of a work, which is copied after to make another like it. Among minters it is used for the standard weight by which the others are adjusted. The archetypal world, among Platonists, means the world as it existed in the idea of God, before the visible creation.

ARCHIL. See LICHEN.

ARCHIMEDES, in biography, one of the most celebrated mathematicians among the ancients, who flourished about 250 years before Christ, being about 50 years later than Euclid. He was born at Syracuse in Sicily, and was related to Hiero, who was then king of that city. The mathematical genius of Archimedes set him with such distinguished excellence in the view of the world, as rendered him both the honour of his own age, and the admiration of posterity. He was indeed the prince of the ancient mathematicians, being to them what Newton is to the moderns, to whom in his genius and character he bears a very near resemblance. He was frequently lost in a kind of reverie, so as to appear hardly sensible; he would study for days and nights together, neglecting his food; and Plutarch tells us that he used to be carried to the baths by force. Many particulars of his life, and works, mathematical and mechanical, are recorded by several of the ancients, as Polybius, Livy, Plutarch, Pappus, &c. He was equally skilled in all the sciences, astronomy, geometry, mechanics, hydrostatics, optics, &c. in all of which he excelled, and made many and great inventions.

Archimedes, it is said, made a sphere of glass, of a most surprising contrivance and workmanship, exhibiting the motions of the heavenly bodies in a very pleasing manner.

Many wonderful stories are told of his discoveries, and of his very powerful and curious machines, &c. Hiero once admiring them, Archimedes replied, these effects are nothing, "but give me," said he, "some other place to fix a machine on, and I will move the earth." He fell upon a curious device for discovering the deceit which had been practised by a workman, employed by the said king Hiero to make a golden crown. Hiero, having a mind to make an offering to the gods of a golden crown, agreed for one of great value, and weighed out the gold to the artificer. After some time he brought the crown home of the full weight; but it was afterwards discovered or suspected that a part of the gold had been stolen, and the like weight of silver substituted in its stead. Hiero, being angry at this imposition, desired Archimedes to take it into consideration, how such a fraud might be certainly discovered. While engaged in the solution of this difficulty, he happened to go into the bath; where observing that a quantity of water overflowed, equal to the bulk of his body, it presently occurred to him, that Hiero's question might be answered by a like method; upon which he leaped out, and ran homeward, crying out ευρηκα! ευρηκα! I have found it out! I have found it out! He then made two masses, each of the same weight as the crown, one of gold and the other of silver; this being done, he filled a vessel to the brim with water, and put the silver mass into it, upon which a quantity of water overflowed equal to the bulk of the mass; then taking the mass of silver out he filled up the vessel again, measuring the water exactly, which he put in; this shewed him what measure of water answered to a certain quantity of silver. Then he tried the gold in like manner, and found that it caused a less quantity of water to overflow, the gold being less in bulk than the silver, though of the same weight. He then filled the vessel a third time, and putting in the crown itself, he found that it caused more water to overflow than the golden mass of the same weight, but less than the silver one; so that, finding its bulk between the two masses of gold and silver, and that in certain known proportions, he was able to compute the real quantities of gold and silver in the crown, and so manifestly discovered the fraud.

Archimedes also contrived many machines for useful and beneficial purposes; among these, engines for launching large ships; screw pumps, for exhausting the water out of ships, marshes or overflowed lands, as Egypt, &c. which they would do from any depth.

But he became most famous by his curious contrivances, by which the city of Syracuse was so long defended, when besieged by the Roman consul Marcellus; showering upon the enemy sometimes long darts and stones of vast weight and in great quantities; at other times lifting their ships up into the air, that had come near the walls, and dashing them to pieces by letting them fall down again; nor could they find their safety in removing out of the reach of his cranes and levers, for there he

contrived to set fire to them with the rays of the sun reflected from burning glasses.

However, notwithstanding all his art, Syracuse was at length taken by storm, and Archimedes was so very intent upon some geometrical problem, that he neither heard the noise, nor regarded any thing else, till a soldier that found him tracing lines, asked his name, and upon his request to be-gone, and not disorder his figures, slew him. "What gave Marcellus the greatest concern, says Plutarch, was the unhappy fate of Archimedes, who was at that time in his museum; and his mind, as well as his eyes, so fixed and intent upon some geometrical figures, that he neither heard the noise and hurry of the Romans, nor perceived the city to be taken. In this depth of study and contemplation, a soldier came suddenly upon him, and commanded him to follow him to Marcellus; which he refusing to do, till he had finished his problem, the soldier, in a rage, drew his sword, and ran him through." Livy says he was slain by a soldier, not knowing who he was, while he was drawing schemes in the dust; that Marcellus was grieved at his death, and took care of his funeral; and made his name a protection and honour to those who could claim a relationship to him. His death it seems happened about the 142d or 143d Olympiad, or 210 years before the birth of Christ.

When Cicero was quæstor for Sicily, he discovered the tomb of Archimedes, all overgrown with bushes and brambles; which he caused to be cleared, and the place set in order. There were a sphere and cylinder cut upon it, with an inscription, but the latter part of the verses were quite worn out.

Many of the works of this great man are still extant, though the greatest parts of them are lost. The pieces remaining are as follow: 1. Two books on the Sphere and Cylinder.—2. The Dimension of the Circle, or Proportion between the Diameter and the Circumference.—3. Of Spiral lines.—4. Of Conoids and Spheroids.—5. Of Equiponderants, or Centres of Gravity.—6. The Quadrature of the Parabola.—7. Of Bodies floating on Fluids.—8. Lemmata.—9. Of the Number of the Sand.

Among the works of Archimedes which are lost, may be reckoned the descriptions of the following inventions, which may be gathered from himself and other ancient authors. 1. His Account of the Method which he employed to discover the Mixture of Gold and Silver in the Crown, mentioned by Vitruvius.—2. His Description of the Cochleon, or engine to draw water out of places where it is stagnated, still in use under the name of Archimedes's Screw. Athenæus, speaking of the prodigious ship built by the order of Hiero, says, that Archimedes invented the cochleon, by means of which the hold, notwithstanding its depth, could be drained by one man. And Diodorus Siculus says, that he contrived this machine to drain Egypt, and that by a wonderful mechanism it would exhaust the water from any depth.—3. The Helix, by means of which, Athenæus informs us, he launched Hiero's great ship.—4. The Trispaston, which, according to Tzetzes and Oribasius, could draw the most stupendous weights.—5. The Machines, which, according to Polybius, Livy, and Plutarch, he used in the defence of Syracuse against Marcellus, consisting of Tormenta, Balistæ, Catapults, Sagittarii, Scorpions, Cranes, &c.—6. His Burning Glasses, with which he set fire to the Roman gallies.—7. His Pneumatic and Hydrostatic Engines, concerning which subjects he wrote some books, according to Tzetzes, Pappus, and Tertullian.—8. His Sphere, which exhibited the celestial motions. And probably many others.

A considerable volume might be written upon the curious methods and inventions of Archimedes, that appear in his mathematical writings now extant only. He was the first who squared a curvilineal space; unless Hypocrates be excepted on account of his lunes. In his time the conic sections were admitted into geometry, and he applied himself closely to the measuring of them, as well as other figures. Accordingly he determined the relations of spheres, spheroids, and conoids to cylinders and cones; and the relations of parabolas to rectilineal planes whose quadratures had long before been determined by Euclid. He has left us also his attempts upon the circle: he proved that a circle is equal to a right-angled triangle, whose base is equal to the circumference, and its altitude equal to the radius; and consequently, that its area is equal to the rectangle of half the diameter and half the circumference; thus reducing the quadrature of the circle to the determination of the ratio between the diameter and circumference; which determination however has never yet been done. Being disappointed of the exact quadrature of the circle, for want of the rectification of its circumference, which all his methods would not effect, he proceeded to assign an useful approximation to it: this he effected by the

numeral calculation of the perimeters of the inscribed and circumscribed polygons: from which calculation it appears that the perimeter of the circumscribed regular polygon of 192 sides is to the diameter in a less ratio than that of $3\frac{1}{7}$ or $3\frac{10}{70}$ to 1; and that the perimeter of the inscribed polygon of 96 sides is to the diameter in a greater ratio than that of $3\frac{10}{71}$ to 1; and consequently that the ratio of the circumference to the diameter lies between these two ratios. Now the first ratio, of $3\frac{1}{7}$ to 1, reduced to whole numbers, gives that of 22 to 7, for $3\frac{1}{7} : 1 :: 22 : 7$; which therefore is nearly the ratio of the circumference to the diameter. From this ratio between the circumference and the diameter, Archimedes computed the approximate area of the circle, and he found that it is to the square of the diameter, as 11 is to 14. He determined also the relation between the circle and ellipse, with that of their similar parts. And it is probable that he likewise attempted the hyperbola; but it is not to be expected that he met with any success, since approximations to its area are all that can be given by the various methods that have since been invented.

Beside these figures, he determined the measures of the spiral, described by a point moving uniformly along a right line, the line at the same time revolving with a uniform angular motion; determining the proportion of its area to that of the circumscribed circle, as also the proportion of their sectors.

Throughout the whole works of this great man, we every where perceive the deepest design, and the finest invention. He seems to have been, with Euclid, exceedingly careful of admitting into his demonstrations nothing but principles perfectly geometrical and unexceptionable: and although his most general method of demonstrating the relations of curved figures to straight ones, be by inscribing polygons in them: yet to determine those relations, he does not increase the number, and diminish the magnitude, of the sides of the polygon *ad infinitum*; but from this plain fundamental principle, allowed in Euclid's Elements, (*viz.* that any quantity may be so often multiplied, or added to itself, as that the result shall exceed any proposed finite quantity of the same kind), he proves that to deny his figures to have the proposed relations would involve an absurdity. And when he demonstrated many geometrical properties, particularly in the parabola, by means of certain progressions of numbers, whose terms are similar to the inscribed figures; this was still done without considering such series as continued *ad infinitum*, and then collecting or summing up the terms of such infinite series.

There have been various editions of the existing writings of Archimedes. But the most complete of any is the magnificent edition, in folio, lately printed at the Clarendon press, Oxford, 1792. This edition was prepared ready for the press by the learned Joseph Torelli, of Verona, and in that state presented to the university of Oxford. The Latin translation is a new one. Torelli also wrote a preface, a commentary on some of the pieces, and notes on the whole. An account of the life and writings of Torelli is prefixed, by Clemens Sibiliati. And at the end a large appendix is added, in two parts; the first being a Commentary on Archimedes's paper upon Bodies that float on Fluids, by the Rev. Adam Robertson of Christ Church College; and the latter is a large collection of various readings in the manuscript works of Archimedes, found in the library of the late King of France, and of another at Florence, as collated with the Basil edition abovementioned.

ARCHITECTURE is the art of forming dwellings, or erecting buildings of any kind.

Animals of acute feelings, exposed to disagreeable extremes of seasons, uncertainties of weather, and to the depredations and attacks of each other, must have a strong desire to shelter and secure themselves. Consequently, those favoured by nature either for digging in the earth or building would, under these pressing circumstances, soon form places of retirement for themselves; and other animals, without such powers, would endeavour to seek such places of shelter as are either furnished by nature itself, or formed by others. Thus birds and insects build themselves nests; many kinds of quadrupeds form subterraneous retreats; and in time of storms cattle flee, and endeavour to shelter themselves among rocks, trees, &c. There can be little doubt but building began first among the brutes; but their modes of working have been uniformly the same from time to time, without improvement. Man, with feelings much more acute than any other animal, and also superior, both from his reasoning powers, and the construction of his frame, in being adapted to lift, remove, shape, and place inanimated matter wherever his mind di-

rects, and from his imitative disposition, would be compelled by pressing necessity to form some kind of habitation where he might breathe the temperate air, amid the summer's heat, or winter's cold, secure himself from the attacks of ferocious animals, and when nature calls he might rest and sleep in ease and security. It is probable that the original habitations of men were natural caverns in the earth, and hollows in the trunks of trees. Also, from the example of brutes, he might excavate the ground; but being disgusted with darkness and damps, taking example from the birds, he would begin to build huts of such materials as the situations would afford: the natural caverns might suggest the idea of using earth or stones. That the first attempts at building must have been extremely rude there can be little doubt; men, without cutting instruments or tools, could not shape, smooth, break, and join timbers or stones, as they do in the present day; timbers could only be supported by balancing each other, or driving them fast into the ground, or piling stones or other materials around their lower ends, or interlacing them with slender twigs or boughs.

It is reasonable to conjecture, that wherever wood is found, the primitive hut would be constructed of a conic figure, not only from its form being the most simple of all solids, but also from the ease with which this covering is made. The builder collecting a few boughs, and perhaps breaking them to determinate lengths, would support them by leaning them against each other at the top, and spreading them out at the bottom, so as to make the interior of sufficient capacity, leaving an aperture on one side for entrance: the interstices he would interweave with smaller branches, and to render it impervious to disagreeable changes, or excesses of the surrounding element, he would plaster the interstices with mud, slime, or clay; such are the wigwams of the North American Indians, and the kraals of the Hottentots and Caffrees, in the present day. It would not be long before the inhabitant saw the inconvenience of the simple conic form, on account of its inclined sides, in preventing him from standing erect at the extremities of the floor. His former dwelling would readily suggest the plan on which he was to build. He might perhaps begin to dispose the timbers upright, and fasten their bottom ends as above, or by setting them upon the ground only, and interweaving interstices in the manner of basket work; or perhaps by combining both these methods together, so as to make his hut still more durable: in this manner the first walls might have been made, or by collecting the most portable and shapely stones, and rearing a rough wall to a sufficient height: the roof would be constructed of the conic or pyramidal figure, as formerly, and the whole plastered over with mud, or any other tenacious material.

As mankind began to associate, they would improve each other by degrees; and having found the use of tools, trunks of trees, divested of their bark and branches, would be used as pillars, and beams or lintels, instead of ramified boughs. In this improved state of joining and cutting the timbers, the beams would no doubt suggest a rectilineal plan instead of the circular one, as beams of the circular form could not be so readily procured as those of the straight form, the triangle being the only figure that includes a space by the fewest sides, it may first have been employed for the plan; but finding this form of building inconvenient, on account of the acuteness of its angles, the rectangle would be adopted in its stead, the hut erected thereon would have the form of a rectangular prism, which figure has been generally retained to the present day, with little variation, by almost the whole inhabitants of the globe, and exactly by those who live in the mildest climates; but in countries liable to rain, pyramidal and wedge-formed roofs have been constantly in use. From this state of the hut has civil architecture advanced progressively to the present state of improvement. Vetruvius, the most ancient writer of architecture, informs us nearly as above, in the following words:

"Mankind began to make themselves coverings with the boughs of trees; some dug caves in the mountains; and others, in imitation of the nests of swallows, with sprigs and loam made shelters which they might lye under; and by observing each others work and turning their thoughts to discover something new, they by degrees improved and made better kinds of habitations; but men being of an imitative and docile nature, glorying in their daily inventions, and shewing one another the houses they had made, they by these endeavours and exertions of their faculties became in time more skilful.

"At first for the walls they erected forked stakes, and disposing twigs between them, covered them with loam; others piled up dry clods of clay, binding them together

with wood, and to avoid rain and heat, they made a covering with reeds and boughs; but finding that this roof could not resist the winter rains, they made it sloping and pointing at the top, plastering it over with clay, and by that means dissharged the rain water. That the origin of things was as above written may be concluded from observing, that to this day some foreign nations construct their dwellings of the same kind of materials, as in Gaul, Spain, Lusitania, and Aquitain, they use oak shingles or straw. The Colchians, in the kingdom of Pontus, where they abound in forests, fix trees in the earth, close together in ranks to the right and left, leaving as much space between them as the length of the trees will permit; upon the ends others are laid transversely, which circumclude the place of habitation in the middle; then at the top the four angles are braced together with alternate beams; and thus the walls, by fixing other trees perpendicularly on these below, may be raised to the height of towers. The interstices which, on account of the coarseness of the materials, remain, are stopped with chips and loam. The roof is also raised by beams laid across from the extreme angles, gradually converging, and rising from the four sides to the middle point at the top, and then covered with boughs and loam. In this manner the barbarians make the testudinal roofs of their towers. The Phrygians, who inhabit a champaign country, being destitute of timbers by reason of the want of forests, select little natural hills, excavate them in the middle, dig an entrance, and widen the space within as much as the nature of the place will permit: above they fix stakes in a pyramidal form, bind them together and cover them with reeds or straw, heaping thereon great piles of earth. This kind of covering renders them very warm in winter and cool in summer; some also cover the roofs of their huts with the weeds of lakes; and thus in all nations and countries the dwellings are formed upon similar principles. At Marseilles we may observe the roofs without tiles, and covered with earth and straw. At Athens the Areopagus is an example of the ancient roofs of loam: at the Capitol also the house of Romulus in the sacred citadel may remind us of the ancient manner of covering our roof with straw. By these examples therefore we may be assured, that the first inventions of building happened in the manner we have related; but at length mankind by daily practice improved, and by repeatedly exercising their faculties and talents arrived at the full knowledge of the art, those who were most experienced professing themselves artificers. When therefore these things were thus far advanced, as nature had not only given to mankind sense in common with other animals, but had also furnished their minds with judgment and foresight, and had subjected other animals to their power, they from the art of building gradually proceeded to other arts and sciences, and from a savage and rustic way of life became humane and civilized. Then when their minds were thus enlightened, and they became more judicious by experience, and the advancement of the various arts and sciences, they no longer built huts, but founded houses with walls constructed with bricks, stones, or other materials, covering the roofs with tiles."

HISTORY OF ARCHITECTURE.

The origin of architecture is, like that of most other arts, involved in great obscurity. We are informed by Moses that Cain built a city, and called it after the name of his son Enoch; but concerning the mode of constructing the houses, or the quality of the materials, he is quite silent. The same author also informs us that Jabal was the father of such as dwell in tents. In the days of Noah architecture must have arrived at great perfection: to construct the ark of sufficient strength to withstand the tempests raging over the surface of the watery element would require considerable skill in the art of carpentry. Ashur built the cities of Nineveh, Rehoboth Calah, and Resen. The city and tower of Babel were built of well-burnt brick, and slime for mortar. Brick-making must have been well understood then, and perhaps at a period much anterior. Moses does not say, what either the dimensions or figure of the tower was, but that it was the intention of the people to make its top reach unto heaven: this vain design being frustrated by the intervention of the Almighty, the building was left unfinished. Whether this city and tower be the same Babylon and tower as described by Herodotus and Strabo is uncertain; the former says it was a square building, each side of which at the base was a furlong, consequently half a mile in circumference; from a winding stair, or rather an inclined plane, which went around the exterior, making eight revolutions, the building appeared as if eight stories had been placed one upon the other; each such story was 75 feet high, and con-

sequently the whole height 600 feet: the inclined plane was so broad as to allow carriages to pass each other.

From very remote antiquity the Egyptians have been celebrated for their cultivation of architecture among other arts; the ruins of their ancient structures astonish the traveller of the present day, as may be seen in their huge pyramids and proud tombs, which have long outlived the memory of the mighty kings whose ashes they contain: granite temples as extensive as towns, which inclose in their courts or support upon their roofs villages of the modern inhabitants; long avenues of sphinxes, colossal statues, and obelisks. Yet the art of building among them consisted of but few principles, for they did not seem to understand the use of the arch; all the apertures and intercolumns of their walls were linteled with solid stone; the roofs of the chambers of their temples were generally covered with massy slabs for lintels; the ceiling or roof of the passage within the great pyramid is formed of stones in horizontal courses, projecting equally over each other from the two opposite walls to the summit, like inverted flights of steps: the roofs of some of their tombs are indeed arch formed, but these are only excavations cut out of the solid rock. Their walls were built of stones of an enormous size, without cement. The removal and placing of these huge materials would, even at this day, almost bid defiance to the boldest and best constructed of our mechanical inventions, though conducted with all the science of modern times. The stones of their edifices are squared and jointed with the utmost accuracy; the hieroglyphic carvings with which their walls and ceilings are charged are all recessed, but projecting in relief from the bottoms or backs of the recesses. The forms of Egyptian temples and gates are generally truncated rectangular pyramids, crowned with a cove and fillet, or cavetto, as a cornice around the four angles of the sides, and under the cornice project tori from each face. The entrance front of the temples has generally a large rectangular opening, in which are placed columns for supporting the architrave and cornice: over the middle of the door, and upon the linteling architrave, is carved a winged globe: the height of the columns, according to Denon's representation, is from five to six diameters. The columns have in general little or no diminution, and are frequently placed upon a plinth, from which they sometimes rise in a convexity, forming what is called by workmen a quirk above the plinth. The shafts of the columns are generally divided into two or more compartments, and sometimes charged with hieroglyphics, as well as the walls and ceilings: the compartments are sometimes also ornamented with vertical reeds, representing a bundle of rods, and separated from each other by annular incisions, or beads, which seem as bandages for tying the rods together. The whole of the compartments are not always reeded: sometimes there are only one or two, and the rest carved with hieroglyphics. The capitals sometimes swell out at the bottom from the upper part of the shaft, and diminish to the top, which is covered with a square projecting abacus; sometimes capitals have vases like the Corinthian order, which rise with a small convexity from the shaft, and change into a large concavity upwards, which as it approaches the top has more and more curvature until it terminates: above the termination it recedes with a convexity to the abacus, which is also recessed within the face of the linteling architrave. Sometimes the capitals are formed by the head of Isis, with a temple in miniature placed over it, and then crowned with the square abacus recessed; the lower parts of the intervals between the columns are shut by a kind of parapet, reaching from three to three and a half diameters from the ground. This parapet is sometimes flush with the columns; but is not extended so as to hide their convexity on the front, which shews nearly a quarter of the circumference.

Architecture has also been carried to a wonderful extent among the ancient inhabitants of India, who have not only rivalled the Egyptians, but have been supposed to be even anterior to them in the knowledge of the art; their exertions were, however, directed almost exclusively to excavation.

The Assyrians have been much reputed for their knowledge in the art of building: the walls of Nineveh and Babylon were of wonderful magnitude. Those of the latter were double, and surrounded with a ditch; the outer wall was regularly fortified; it was 15 miles square, or 60 in circumference, 200 royal cubits high, and 50 thick: in the circumference were placed 100 massy gates of brass; and on the top, watch-towers, corresponding to each other. The materials used in the construction of these works, were square bricks, baked in a furnace, and heated bitumen, mixed with the tops of reeds; this composition was placed between every thirteen courses of bricks;

from this circumstance it is probable, that the method of reducing calcareous stones into lime for mortar was unknown at this time. The walls of Babylon are described to be one of the seven wonders of the world; they were first built by queen Semiramis, in the time of her regency, during the minority of her son Ninias; and it would seem that they were afterwards improved by the great Nebuchadnezzar. Of these mighty works there are no remains, nor hardly any trace of the ancient city.

In the ruins of Persepolis, though the columns are of a character somewhat different from those of Egypt; yet the Egyptian style of building may be retraced in various parts of these ruins. Diodorus Siculus says, that the famous palaces of Susa and Persepolis were not built till after the conquest of Egypt by Cambyses, and that they were both conducted by Egyptian architects; it therefore seems probable that the Persians received the art of building in unwrought stone from the Egyptians.

The Phœnicians were also very celebrated for their arts of design, but few or none of their works have reached the present time.

In the vast structures of Asia and Africa, greatness of design, ponderosity of parts, and stones of immense magnitude, seem to have been more regarded than elegance or utility: in all those great works there is no trace of an arch, but what is excavated out of the solid rock, or may be made of a single stone. The Greeks profess to have derived the knowledge of architecture from the Egyptians, but the art of building has been so much improved by transplanting, that scarcely any trace of the original remains: their edifices were at first constructed of wood and clay, but they soon began to imitate the wooden posts and beams of the original hut in stone and marble: from this imitation arose the first order in architecture, which also gave birth to two others. This ingenious people, favoured by nature with marble and other building materials, and, like the Egyptians, being anxious to make their works durable, employed very weighty stones in the construction, which, although laid without cement, as was the practice of all ancient nations, yet they were jointed with the utmost accuracy, which is the reason of the perfect state of their edifices at this day. There is little doubt but that the Greeks were the inventors of the arch, though they never considered it as an ornament; it is only to be found in the theatres and gymnasia; the apertures of walls and intercolumns being linteled.

Greece, though a mild climate, is sometimes liable to rain; the architects of this country, therefore, found it necessary to raise the roofs of their edifices, to a ridge in the middle, the section being that of a rectilineal isosceles triangle: the base being the span or distance between the opposite walls. This form of roof, called a pediment roof, was frequently covered with marble tiles.

The Grecians surpassed all contemporary nations in the arts of design; the remains of their ancient structures are models of imitation, and confessed standards of excellence. They were the inventors of three orders of architecture, of which we have already hinted, and which we shall detail in a subsequent part of this article. The remains of their sculptures far exceed that of any other people, and are, even at this day, most perfect models. Modern artists have no means so certain, in attaining a just knowledge of their profession, as in the study of those exquisite master-pieces.

The progress of Grecian architecture appears to have occupied a period of about three centuries, from the age of Solon to the death of Alexander; and in this period it advanced rapidly, particularly from the defeat of Xerxes, to the death of Pericles, at which time it attained its utmost degree of excellence, and continued to flourish till the time it became a Roman province.

Prior to the Macedonian conquest, all the temples of Greece, and its colonies in Sicily and Italy appear to have been of the Doric order; and of one general form, though slightly varied in particular parts, as occasional circumstances might require: their plan was an oblong, having one column more on the flank than double the number of those in front.

The ancient Etrurians have left many excellent monuments of taste, and to them is generally ascribed the method of building with small stone and mortar, made of calcareous stone; and this seems probable, as the most ancient vestiges of cementitious buildings are to be found in the country which the present Tuscans inhabit.

They were employed by the Romans in many public works; the walls of the city of Rome were made of hewn stone, the capitol and the cloaca maxima are of their construction; the last of these is esteemed a very extraordinary piece of architecture, as

is sufficiently proved by its remains. To these people is attributed the invention of one of the orders of architecture, called after them the Tuscan.

We are told by Vitruvius, that the intercolumns of their temples were wide, and that they were linteled with wooden architraves.

The Romans appear to have had their first knowledge of architecture from the Etrurians: but it was not till after the conquest of Greece, that they acquired a just relish for its beauties. It seems to have attained to its highest degree of excellence in the reign of Augustus, and continued to flourish till the seat of empire was removed to Byzantium. The works of the Romans were much more numerous than those of any other people. The remains of their palaces, theatres, amphitheatres, baths, mausoleums, and other works, excite at this day the admiration and astonishment of every judicious beholder. Their first temples were round and vaulted, and hence they are accounted the inventors of the dome. The plans of their buildings were more varied than those of the Greeks, who, excepting but in a few instances of small, but beautiful specimens, such as the Tower of the Winds, and the monument of Lycicrates, erected their principal edifices upon rectangular plans. The Romans constructed circular temples crowned with domes, amphitheatres upon elliptic plans, and their theatres, and many other buildings, upon mixt-lined plans. By this variety they formed a style that was both elegant and magnificent. But let it be remembered, that notwithstanding the grandeur, the magnitude, and number of their works, their style was never so pure as in the flourishing ages of Greece. Among the Romans, entablatures were frequently omitted, columns were made to support arches and groined vaults; arcades were substituted for colonades, and vaults for ceilings. In several of their most magnificent public buildings we find stories of arcades upon each other, or in the same front with the solid parts of the masonry decorated with the orders, which, instead of forming an essential part in the construction, are degraded to idle and ostentatious ornaments. This is very conspicuous in the theatre of Marcellus, and in the Coliseum.

It is probable that the arch was invented in Greece, but was almost constantly employed by the Romans, who not only considered it necessary in the construction, but as an ornament, which they lavishly employed in the apertures of walls, and in the ceilings over passages and apartments of their buildings. Particularly in the decline of the empire, from the reign of Constantine, and upon the establishment of Christianity, external magnificence was every where sacrificed to internal decoration. The purity of taste in the arts of design declined rapidly, and finally perished with the extinction of the empire. The most beautiful edifices, erected in the preceding reigns, were divested of their ornaments, to decorate the churches. In this age of spoliation, architects, deficient in the knowledge of their profession, adopted the most ready modes of construction: to accomplish this, many beautiful structures were deprived of their columns, and placed at wide intervals in the new buildings; and over the capitals were thrown arches for the support of the superstructure: most of the ornamental parts were taken from other buildings, which were spoiled for the purpose. The edifices of Italy now assumed the same general features as those which characterised the middle ages. This disposition is the plan of the Roman basilicas, but is more nearly allied, in the elevation, to the opposite sides of the Egyptian oeci, which has also the same plan as the basilica, and which was of similar construction to the churches in after times, excepting in the want of arches: both had a nave, with an aisle upon each flank, separated from the nave by a range of columns, which supported a wall, pierced with windows for lighting the nave: against this wall, and over the columns, were placed other attached columns. This, when roofed over with a groined ceiling, such as that of the Temple of Peace, will form the interior of a building, similar to that of the Saxon churches.

The Corinthian order was the favourite order among the Romans, and as far as existing examples enable us to judge, the only order well understood, and happily executed.

What we now call the Composite order, is of Roman extraction: it was employed in many of their buildings, but chiefly in the triumphal arches: from what we find in Vitruvius, it was never accounted a distinct order, but as a species of the Corinthian only. The only existing example that Rome affords of the Doric order, is that executed in the theatre of Marseilles, and, though in the age of Augustus, is but a vitiated composition: the columns are meagre and plain,

divested of that sublime grandeur and elegance which are so conspicuous in the solidity and flutings of the Grecian Doric. The dentils in the cornice are too effeminate a substitute for the masculine mutules which are so characteristic of the origin of this order.

The Ionic in the same building is ill executed. The channels of the volutes, of the capitals, of the Ionic columns on the Coloseum, and the dentil band of the cornice, are not cut. The Ionic order of the Temple of Fortune, though it has been held out as a model, is ill proportioned, and the spirals of the volutes are ungracefully formed. The Ionic of the Temple of Concord is out of character, the volutes are insignificantly small, and mutules supply the place of dentils in the cornice. The Romans placed one order upon another, on the exterior, in the several stories of some of their buildings; but the Greeks only employed them around the cells of their temples, forming a peristyle.

The Romans carried the method of cementitious buildings to the utmost degree of perfection. Their most considerable edifices had the facings of their walls, and the arches and angles of brick, or small ruble stones squared; the cores built with pebble and ruble stones, grouted or run with liquid mortar; and at regular intervals were strengthened with courses of bond stones. This construction of walls was frequently stuccoed, or incrusted with marble. It is much more expeditious and economical than that built of wrought stone, which occasions a greater waste of materials and loss of time. The durability and solidity of the Roman cementitious buildings is such, that mortar has acquired a hardness superior to the stones which connected by it. This, when compared with the frigility and crumbling nature of the mortar used by modern builders, had led some to suppose that the ancients possessed processes in the making of cements, which have, from the lapse of time, been lost to the present day. But the information and experiments of ingenious men have exploded this opinion; and there is no doubt, that if proper attention be paid to the choice of lime-stone and sand, to the burning of the lime, and above all, that care be taken in the mixing and tempering these materials, workmen will be enabled to rival those of Rome. This has been tried in some instances, though the lapse of ages may be necessary to make the comparison complete; however, it will appear from the following account of Vitruvius, that the method of making lime by the Romans was not very different from what it is at the present day. "Lime should be burnt from white stone, or flint, of which the thick and hard sort are more proper for building walls, as those which are porous are for plastering. When the lime is burnt the ingredients are thus to be mixed: with three parts of pit sand, one part of lime is to be mingled; but if river or sea sand is used, two parts of sand, and one of lime must be united; for in these proportions the mortar will have a proper consistence: if bricks, or tiles, pounded, and sifted, be joined with river or pit sand, to the quantity of a third part, it will make the mortar stronger and fitter for use."

The works of wrought stone of the Romans as well as those of the Greeks, were constructed without cement; but cramps and ligatures of iron and bronze were used in great abundance. The use of metal was not confined to cramps and bolts, for they even constructed roofs of bronze, which was also used in magnificent profusion in the decorations of buildings. It excites regret to reflect, that the means employed by the antients to increase the beauty, and ensure the duration of their edifices, have only, in many instances, served to accelerate their destruction.

These valuable materials have caused much dilapidation, and more buildings have been ruined by rapine, than by the injuries of time. In the works of the Greeks and the Romans, of hewn stone, they appear to have wrought only the beds of the stones, before they were placed in the building, leaving the faces to be worked after the completion of the edifice. By this means, the arisses and the mouldings were preserved from injury, and the faces made exactly in the same plane, or surface, which is not generally the case in the facings of our modern works. Our workmen pass them over in the most slovenly manner, with the greatest indifference, by rounding the stones which happen to project at the joints, which gives them a false and irregular appearance in sunshine. By this means, also, the ancients diminished and fluted their columns, which could not be done with the same accuracy any other way.

After the fall of the Roman empire, the Goths having now the dominion of those places formerly the seat of the arts, and having soon become converts to Christianity, but having no established rules of their own, in the principles of architecture, either built

their churches in the form of the Roman basilica, or converted the basilica into churches. Architecture continued during their government with little alteration in the general forms, from that which had been practised at the decline of the Roman empire; but ignorance in proportion, and a depraved taste in the ornamental department, at last deprived their edifices of that symmetry and beauty which were so conspicuous in the works of the ancients. However, the knowledge of architectural elements was still preserved among them, and of the various forms of vaulting used by the Greeks and Romans, they adopted that of groins or cross arching.

From what has been said, it will be easy to shew, that the Goths had no share in the invention of that style of building which still bears their name. The architecture of Italy, at the time they ceased to be a nation, was nothing but debased Roman, which was the archetype for the first Saxon churches erected in this country. The term Gothic seems to have originated in Italy, with the restorers of the Grecian style, and was applied by the followers of Palladio and Inigo Jones, to all the structures erected in the interval between the beginning of the twelfth and end of the fifteenth centuries, probably with a view to stigmatize those beautiful edifices, and to recover the ancient manner. This term is therefore of modern application: it was not used in Italy till the pointed style had gained the summit of perfection, nor yet in England, when this species of architecture ceased to be in use, and the Grecian restored. This manner of building, like most other arts, required a succession of ages to bring it to maturity, and the principal cause which seems to have effected this, was that desire of novelty so inherent in the mind of man to produce something new, and a total disregard to the proportions of ancient edifices. Having now traced the Grecian style from the place of its invention to its decline in Italy, we shall follow the steps by which this corrupted ill-proportioned Italian style at last assumed a character so different from the original, as to become in a few centuries a distinct species of architecture, which not only exhibited beautiful proportions, and elegant decorations, but also majestic grandeur and sublimity in its fabrication. To do this, it will not be necessary to seek abroad for those successive changes; as the different gradations can be distinctly traced at home. The first Saxon churches here were either constructed, with however rude imitation, after models of Roman temples, which we may presume then remained in Britain, or by foreigners brought from Rome and France. The manner of building at this time was called Roman, the term Gothic not being applied till the end of several centuries.

It has been observed, that a quadrangular walled inclosure, divided in the breadth into three parts, by two colonaded arcades, supporting on the imposts of the arches, two other opposite higher walls, through which the light descended into the middle part, and upon which the roof rested, was known to the Romans before the Goths appeared in Italy. Now this construction is the general outline of the Saxon, Norman, and the pointed styles of building churches, and is also that form of structure most advantageous for lighting the interior, upon the same plan; for, though the roof might have been equally well supported by columns, instead of the interior walls, and extending those of the exterior to the whole height, the intensity of light produced from the same number of windows on the sides, thus far removed from the middle of the edifice, would have been greatly diminished. It may also be farther observed, that no other form of building was so favourable for vaulting: for a vaulted roof could neither have been thrown to the whole breadth, nor in the three compartments, without walls of enormous thickness, which would not only have added to the breadth, but would have been attended with prodigious additional expenses.

The Saxon style is easily recognized by its massive columns and semicircular arches, which usually spring from capitals without the intervention of the entablature. In the first Saxon buildings the mouldings were extremely simple, the greater part consisting of fillets and plat-bands, at right angles to each other, and to the general façade. The archivolts and imposts were similar to those found in Roman edifices. The general plan and disposition of the latter Saxon churches were as follow; the chief entrance was at the west end into the nave, at the upper end of which was a cross, with the arms of it extending north and south; the east end, containing the choir, terminated in a semicircular form. A tower was erected over the centre of the cross, and to contain the bells another was frequently added, and sometimes two.

The large churches contained a nave and

two side aisles, one on each side of the nave, and were divided into three tiers or stories, the lower consisting of a range of arcades on each side, the middle, a range of galleries between the roof and the vaulting of the aisles, and the uppermost, a range of windows. The pillars were either square, polygonal, or circular. Such was the thickness of the walls and pillars, that buttresses were not necessary, neither were they in use. The apertures are splayed from the mullions on both sides. The dressings are generally placed on the sides of the splayed jambs and heads of the arches, and but seldom against the face of the walls, and when this is the case, the projectures are not very prominent. The dressings of the jambs frequently consist of one, or several engaged columns upon each side. The imposts, particularly those of the windows, have frequently the appearance of being a part of the wall itself. The doors in general are formed in deep recession, and a series of equidistant engaged columns placed upon each jamb, and were such, that two horizontal straight lines would pass through the axis of each series, and would, if produced, terminate in a point. Each column is attached to a recess formed by two planes, constituting an interior right angle. The angle at the meeting of every two of these recesses formed an exterior right angle, which was sometimes obtunded, and frequently hollowed. The archivolts resting on the capitals of the columns are formed on the soffit shelving, like the jambs below. The ornaments of columns and mouldings are of very simple forms. The rudely sculptured figures which often occur in doorcases, when the head of the door itself is square, indicate a Roman original, and are mostly referable to an æra immediately preceding the conquest.

After the Norman conquest, the general forms of the parts remained the same, though the extent and dimensions of the churches were greatly enlarged; the vaultings became much more lofty, the pillars of greater diameter, the ornaments more frequent and elaborately finished; towers of very large dimensions and great height were placed either in the centre, or at the west end of the cathedral and conventual churches. These were often ornamented with arcades in tiers of small intersecting arches on the outside. About the end of the reign of Henry I. circular arches, thick walls without prominent buttresses, and massive pillars with a kind of regular base and capital, generally prevailed; the capitals of the pillars were often left plain, though there were a few instances of sculptured capitals, foliage, and animals. The shafts of the pillars were usually plain cylinders, or had semicolumns attached to them. The first transition of the arch appears to have taken place towards the close of the reign of Stephen, its figure which had hitherto been circular, becoming slightly pointed, and the heavy single pillar made into a pilastered cluster which was at first ill formed, but gradually assumed a more elegant figure and graceful proportion, the archivolts still retaining many of the Saxon ornaments. It may here be observed, that antecedent to this period, neither tabernacles nor niches with canopies, statues in whole relief, pinnacles, pediments, or spires, nor any tracery in the vaultings were used; but at this time, or soon after, these began to obtain. Towards the close of the 13th century, the pillars, then supporting sharply pointed arches, were much more slender; the ceilings were seemingly sustained by groined ribs resting on the capitals of the pillars, and the windows were lighted by several openings in place of one.

After the reign of Stephen, the circular and pointed arches were frequently employed in the same building; but the pointed style gaining more and more upon the circular, prevailed ultimately at the close of the reign of Henry III. and prevented all farther confusion of mixture. The architecture of this age now exhibited uniformity of parts, justness of proportions, and elegance of decoration; the arcades and pillars became numerous, the single shafts were divided into a multiplicity of equal slender, distinct shafts, constructed of purbeck marble, and collected under one capital, luxuriantly decorated with leaves of the palm tree. The east and west windows began to be widely expanded, these required a number of mullions, which, as well as the ribs and transoms of the vaulting, began to ramify from the springing of the arches into a variety of tracery, which was uniformly ornamented with rosettes or polyfoil, cuspidated figures forming trefoils, quatrefoils, &c. Canopies were introduced over the arches, and in rich work were decorated with crockets and creeping foliage, and terminated in a flower. The buttresses were made in several diminished stages towards the top, and mostly terminated with purfied pinnacles.

In the reign of Edward II. detached

columns were laid aside, and pillars nearly of the same proportion as formerly, with vertical or columnar mouldings wrought out of the solid, were adopted. The east and west windows were so enlarged as to take up nearly the whole breadth of the nave, and carried up almost as high as the vaulting, and were beautifully ornamented with lively colours on stained glass.

In the early part of the reign of Edward III. arcades with low arches and sharp points prevailed; over the arcades was generally placed a row of open galleries, originally introduced in Saxon churches.

About the end of the reign of Richard II. A. D. 1399, the pillars became more tall and slender, forming still more lofty and open arcades, the columns which formed the cluster were of different diameters, the capitals more complicated, the vaults at the intersection of the ribs were studded with knots of foliage, the canopies of the arches were universally purfled, and terminated with a rich knot of flowers: the pilastered buttresses flanking the sides were crowned with elaborate finials, the flying buttresses were formed on segments of circles in order to give them lightness, and strength at the same time.

From the close of the 14th century no remarkable change appears to have taken place; the grander members continued their original dimensions and form, and the ornamental parts became distinguished by greater richness and exuberance.

Another change took place in the reign of Edward IV. its leading features are principally to be seen in the vaultings, the horizontal sections of which had been generally projecting right angles, but were now arches of circles; the surface of the vaults being such as might be generated by a concave curve revolving round a vertical line, as an axis which was immediately over the pillars. This species of groining unknown in preceding ages, was favourable for a beautiful display of tracery. Equidistant concave ribs in vertical planes were intersected by horizontal convex circular ribs, aud the included pannels were beautifully ornamented with cusps, forming an infinite variety of the most elegant tracery, which from its appearance has been denominated fan work.

From the commencement of the reign of King Henry VIII. a mixed or debased style began to take place, from our intercourse with the Italians. The ingenious Mr. Britton, in his valuable architectural antiquities of Great Britain, has classed the various styles in the following order, which we shall adopt, and shall be happy to find the same appropriate terms adopted also in future publications, wherever ideas of the objects represented by them are the subjects of inquiry. We are sensible this is the only means of facilitating a knowledge of this study, by removing equivocal words, and thereby making architectural language intelligible.

First Style. Anglo-Saxon; this will embrace all buildings that were erected between the times of the conversion of the Saxons, and the Norman conquest, from A. D. 599 to A. D. 1066.

Second Style. Anglo Norman, by which will be meant, that style which prevailed from 1066 to 1189, including the reigns of Williams I. and II., Henry I., Stephen and Henry II.

Third Style. English, from 1189 to 1272, embracing the reigns of Richard I., John, and Henry III.

Fourth Style. Decorated English, from 1272 to 1461, including the reigns of Edwards I., II., III., Richard II., Henrys IV., V., and VI.

Fifth Style. Highly decorated florid English, from 1461 to 1509, including the reigns of Edwards IV. and V., Richard III., and Henry VII.

From this æra we loose all sight of congruity; and the public buildings erected during the reigns of Henry VIII., Elizabeth, and James I. may be characterised by the terms of debased English, or Anglo-Italian. Mr. Britton observes, "that during the intermediate time when one style was growing into repute and the other sinking in favour, there will be found a mixture of both in one building, which is not referable to either, and which has constituted the greatest problem in antiquarian science."

Before we leave this subject, it will be necessary to give some account of the materials employed in the fabrication, and of the principles in the construction of those immense piles, which at once united grandeur, magnificence, and awful sublimity in their structure. In the erection of these edifices, heavy cornices, entablatures, and lintels were omitted, and there was seldom occasion to use any stones larger than a man might carry on his back up a ladder from one scaffold to another, though spoke wheels and pullies were occasionally used. From the adoption of such light materials,

and the emulation of the architects, edifices were raised to an incredible height. Hence the lofty towers, and the still more elevated spires that occasion such awful grandeur, and sublime sensations in the mind of the astonished beholder. The ceilings of the churches were formed by groined vaulting, a portion of the pressure of which was directed in the length to the ends, and the remaining pressure to the springing points on the sides.

In the Roman buildings the walls were most commonly without projections, and of vast thickness, which was necessary in a vaulted building, erected upon a rectilineal plan, in order to counteract the efforts of the resisting arches. Hence, if the building had been groined, the weight of the arches would have been thrown upon the springing points. From this it is evident that a vast quantity of materials must have been employed without effect; but this is not the case with the pointed style of architecture, for the walls were thickened by buttresses opposed only to the pressing points: and to aid the resistance with still more powerful effect, the buttresses were surmounted with high pinnacles, and, from their sloping position, their general form was almost one continued prop, in a straight line to the bottom: this straight line was a tangent to the arch. Those that understand the nature of the centre of gravity will easily perceive, that a plain wall will be overturned with much more ease than one with buttresses, of the same length and height, the same quantity of materials being employed in both. The extremity of the aisles was sustained by strong pilastered buttresses on the outside, and the other extremity rested on the imposts or capitals of the pillars. These pillars, with their superincumbent walls, not being assisted as on the outside with buttresses, were liable to be bent with the pressure of the arches, unless the sides of the nave had been of sufficient thickness, which, in many of our churches, experience has proved to be the contrary, by the bending of the walls inwardly, which is a serious defect, and threatens ruin to many of those venerable piles of building. We cannot therefore expect these edifices to rival, in duration, the immortal constructions of Egypt, Greece, and Rome. As to the groining of the nave, the arches were equally resisted on both sides by the flying buttresses, which pressed forcibly at the imposts of the arches. It would appear, that the method practised in the erection of these edifices, was to insert the springing stones as the work went on, but to leave the vaulting to be turned after the walls had been carried up to their full height, and the whole roofed in. The roofs of Gothic buildings were very high pitched, a form, more from choice than necessity, rather adopted in compliance with the pointed and pyramidal style of architecture, than rendered necessary by the climate, being generally covered with lead. These roofs are therefore faulty in burdening the walls with an unnecessary load of timber and lead; and they are also deficient in the construction, by the omission of tye-beams, to counteract their tendency to spread and thrust out the walls.

After having thus discussed the several styles of building, which have been generally and unmeaningly classed under the appellation of Gothic, we must now make a retrogression to Italy, where the Grecian style had been revived for a considerable time, and was flourishing in great purity. Let us therefore retrace the steps by which it again arose to its ancient splendour and magnificence.

Fillipo Brunelleschi, born 1377, may be looked upon as the restorer of ancient architecture, and the founder of the modern style.

After having prepared his mind by the study of the writings of the ancient authors, and the ruins of Roman edifices which he carefully measured, he discovered the orders, and recognized the simple forms and constructions of the ancients, and having thus formed a system upon unshaken principles, he was enabled to construct works with beauty, solidity, and durability. He erected the dome of St. Maria da Fiore at Florence, an undertaking beyond the abilities of any other builder then living: Arnolfo, the original architect of this vast cathedral having been two years dead. This dome, rising from an octangular plan, is of great elevation, and is only inferior in size to that of St. Peter's. It is constructed by two vaults, with a cavity between them, and was erected without centring. It is the only elevated dome supported by a wall without buttresses. From this, and many other buildings erected by Brunelleschi, the learned began to study the works of Vetruvius, and a general taste for the principles of the art began to warm the breasts of the Italians.

Leo Battista Alberta, born A. D. 1398, was the first modern author who published a learned treatise on architecture, from

which he has acquired great reputation, and is justly styled the modern Vitruvius. Following the steps of Brunelleschi, he reformed by his precepts and designs many of the abuses and barbarous practices which then prevailed among his countrymen.

Bramante had a considerable share in the restoration of ancient art, and built many magnificent edifices. Pope Julius II. having projected the rebuilding of St. Peter's upon a scale of unequalled magnificence, entrusted the execution of the design, 1513, to Bramante, who conceived the idea of erecting the lofty cupola upon that immense structure. This vast undertaking was carried on successively by Raphael, San Gallo, and Michael Angelo, to whom the final design and completion of the work is principally due.

Architecture continued to flourish in the 16th century, under the great architects Vignola, Serlio, Palladio, and Scamozzi. To the unremitted assiduity of these distinguished artists in the study of the Roman edifices, and to their invaluable publications, the world has been much indebted for the elucidation of the principles of ancient art.

The list of the celebrated Italian artists closes with Bernini, who flourished in the 17th century.

The Grecian style of building was revived in France in the beginning of the 16th century, and afterwards flourished under several architects of distinguished merit. Their principal works are the palace of Versailles, St. Cyr, the church of Invalids, the façade of the Louvre, a most beautiful modern structure, the Porte St. Denis, and the church of Genevieve, the present Pantheon.

Grecian architecture was restored in England under the celebrated Inigo Jones, born 1572. His distinguished works at Greenwich, Whitehall, and Covent Garden, will ever secure him a name among the architects of the highest reputation.

Sir Christopher Wren, an eminent mathematician and philosopher, as well as an architect of the first rank, has executed many of the finest buildings in London and other parts of England, in the modern style. St. Paul's cathedral, inferior to none but St. Peter's, in point of magnitude, but perhaps superior both in skilful construction and figuration, will perpetuate his name to the latest posterity. The exterior dome of St. Paul's is constructed of wood, and sustained by a cone of 18-inch brick-work, which also supports the lantern above.

The interior dome is also constructed of 18-inch brick-work, which had a course the whole thickness for every five feet, and the intermediate parts had two bricks in length in the thickness. This dome was turned upon a centre which supported itself without any standards from below. From the inclined position of its supporting walls it had little or no transverse pressure, yet, for the greater security, it was hooped with iron at the bottom. This is accurately represented in Gwyn's Section.

Though modern architecture is, for the far greater part, indebted to the constructions and decorations of Grecian and Roman edifices; yet we still retain considerable traces of the Gothic style in many of our buildings.

The spire is of Gothic invention; it is imitated in our churches and some other buildings, by erecting one, or two, or a series of Grecian temples over each other; every superior one being less in its horizontal dimensions than that immediately below.

Frustrums of pyramids and cones are also the ornaments of our steeples; but whether the component parts be one, two, or a series of temples, continually diminished, or temples supporting truncated pyramids, the general contour of the aggregate is still pyramidal.

The plans of Grecian buildings were simple geometrical forms; but these of our structures are symmetrical and complex figures, more in imitation of those of the Romans.

The materials used in our modern buildings are stone, brick, and timber. In rustic buildings the stones are either laid dry or with mortar. In finished edifices, the stones of the facings are squared and laid in mortar, and the backs and cores are most generally made up with brick or ruble. Walls constructed entirely of squared stones are rare; for, allowing the materials may be easily procured in great abundance, a vast expense will be incurred by enormous additional workmanship. This construction of walling is therefore seldom or never used, but in aquatic buildings, where the greatest strength is frequently necessary.

The French have not only shewn much ingenuity in the binding and cementing of walls, but also in the cutting of stones with geometrical exactness, so as to fit vaulted surfaces of variously formed figures.

Iron is used for cramping stones, sometimes in binding the face and back of a wall together, when there is little heart. In domes it is frequently used in circular chains, in order to remove lateral pressure, and make the weight of the superstructure act perpendicularly upon the supports. It is also used in fastening wood together, and wood to stone work.

Timber is used also as ligatures to walls: in this situation it is called bond timber, which also serves for securing the internal finishings. Timber is frequently used in foundations, in floors, in roofing, in internal finishing, &c. Timber, besides being used in bond, flooring, and roofing, in conjunction with stone or brick work, is sometimes used as the only material, excepting the chimnies, nails, and other iron fastenings.

Mouldings. In architectural decorations, the materials are formed into a variety of shapes; which have in any two places sections of equal and similar figures, at right angles to their surface, in these two places; thin forms of this property are called mouldings.

When the section is semicircular, or semielliptical, it is called a torus or astragal; when large, it is called a torus; and when small, an astragal.

When the section is a concave curve, and when the concavity recedes beyond either of the extremities of the curve, the moulding is called a scotia or trochilus.

When the section is concave, one extremity being above the other, and the upper extremity projecting out beyond the lower, and when the lower extremity recedes from a vertical line equal to the greatest recess of the concavity, or more, the moulding is called a cavetto.

When the section is a convex curve, with one extremity below the other, and the upper extremity projecting farther than the lower, without any part of the convexity being lower than the lower extremity of the section, the moulding is called an ovolo or echinus.

When the section is a curve of contrary flexure, like a flat S, the moulding is called an ogee; and when the concave part of the ogee projects, and the convex part recedes, the ogee in this position is called a sima recta; but when the parts lie the contrary way, it is called a sima inversa.

When the section is straight, and is either perpendicular to the horizon, or nearly so, then the flat member is called a fillet, platband, or facia, according to its breadth and comparison with other contiguous mouldings.

When it is very narrow, and either crowns an upper moulding, or divides one member from another, it is called a fillet, or listello; when it is broader, it is called a plat-band or plinth; and when very broad, it is called a facia or face.

Compound Mouldings. When one, two, or a collection of mouldings, with or without fillets, crown a broad flat member, this collection is called a cymatium. Other names are particularly applied to the orders, and are explained under that head.

ORDERS OF ARCHITECTURE.

An order is a decorated imitation of those primitive huts, which consisted of rows of posts, made of the trunks of trees, disposed in the ground around a quadrangular plat; and supporting a covering, which consisted of four lintelling beams, placed on the top of the posts, with other transverse beams, supported again by two of the opposite lintels; and lastly, of three rows of transverse timbers supporting each other, and the lowermost supported by the ends of the transverse beams on each side, in parallel inclined planes, rising from the ends of the transverse beams, till each plane of timbers on the one side, met its corresponding plane on the other; the lowermost timbers on each side, being disposed in pairs, in the same vertical planes with the transverse beams, forming the sides of a triangle, and projecting beyond the lintels, and the uppermost inclined planes of timbers, serving to fix the covering of tyle or stone. From this simple construction arose the first order of architecture, called

Doric Order. The columns were imitated from the wooden posts tapering upwards, as trees do by nature; and placed upon a stone base to prevent them from sinking: vertical channels, or flutes, were cut in the shafts, to hold the spears, or staves, which the early Greeks carried along with them. The capital was formed by circular stones, laid on the tops of the columns, and square ones again upon these, to protect the shafts from rain, and to receive the lintelling beam, which became the architrave: the ends of the joists over the architrave were not in vertical channels, froming the triglyphs, for preventing the rain from adhering to them. The cornice was formed by the projecting timbers of the roof; the ends of the bottom tier of these timbers forming the mutules: the lower sides of which, as well as the un-

derside of the band of the triglyphs, were cut into thin cylinders, or conic frustrums, representing the drops of rain falling from the edges. These parts which at first resulted from the primitive habitation, were afterwards converted into more elegant decorations of simple and natural forms. The general figure of the Attic Doric consists of but few parts, even as practised in the most refined ages of Greece: the fluted shaft, terminating with one, two, or three annular channels: the capital, consisting of the fillets and a bold echinus, having the same common axis with the shaft; and the crowning abacus form the entire column, which therefore consists of a base and shaft. The spacious architrave, resting on the columns, consisting of a crowning band with the gutteré and tenia pending therefrom, under the triglyphs; the frize, consisting of a capital, or cymatium, and equidistant triglyph, leaving square recesses between them called metopes; and the cornice, consisting of mutules over the triglyphs and over the metopes; the corona formed of a band and cymatium above; and the sima, or crowning moulding, formed of a large ovolo and fillet, compose the whole entablature; which therefore consists of a cornice, frize, and architrave. This is the general character of the Grecian Doric. It is almost constantly placed upon three steps, proportioned to the height of the order, and not to the human step; the shafts of the columns diminish with a beautiful curve line from the bottom to the cincture below the annulets: the flutes are without fillets, of a circular or eliptic section, and terminate immediately below the annulets: the annulets of the capital most commonly follow the contour of the ovolo; above them, the band, crowning the top of the architrave, is one continued string without breaks; the guttæ under the regula, and under the mutules, are generally of a cylindrical form, at least tapering upwards in a very small degree.

The triglyphs are placed upon the extremities of the frize, and not over the axis of the extreme columns; and consist of two whole channels, and two half ones upon the edges; the sides of each glyph, or channel, are two vertical planes, meeting each other in a right angle at the back, and consequently the face of the triglyph at 135 degrees on each side of the glyph; the tops of the channels are sometimes curved in the front, like a very eccentric semi-ellipsis, placed with its greater axis horizontal; as in the temple of Theseus, and very frequently with a horizontal line, joined to each vertical line at the side, with a quadrant of a circle, and the tops of the two half channels on each edge of the triglyph, are semicircular, not only in front, but in the profiles also, leaving the angle pendant at the top; as in the temples of Minerva at Athens, and at Sunium, and the temple of Jupiter Panellenius; and sometimes the head of the glyph is horizontal, as in the Doric portico at Athens, and in the temple of Jupiter Nemæus, between Argos and Corinth.

In all these examples, the surface forming the head of a glyph is perpendicular to the front, or such, that a right line, perpendicular to the face, and touching the top line of the head in any point, will coincide with the surface of the interior of the glyph. The capital of the triglyphs has a small projection on the face, which is not returned on the edges, and descends lower than that over the metopes; though both are on the same level at the top.

The mutules are thin parallelopipeds: their lower surface making an acute angle with the upright of the frize, in the same manner as the under ends of the rafters of the primitive hut would; the pendant guttæ hung to them, are in three rows, from front to rear, having six on the front, and also in each of the two back rows. The soffit of the corona is parallel to that of the mutules, and consequently makes an acute angle with the upright of the frize also. The lower part of the corona is most frequently wrought into a fillet, its cymatium is differently formed in different examples; but most frequently with a small ovolo and fillet, both of which are channelled upwards, in order to produce a greater variety of light and shade. The sima, or crowning moulding, most frequently consists of a large ovolo, and a fillet over it.

The general propositions of the Doric order are the following. The columns are six diameters in height: the superior diameter is four-fifths, and the altitudinal dimension of the capital two-fifths of the inferior diameter, including the annulets, echinus, and abacus. The height of the capital is divided into two equal parts, giving the upper one to the abacus, and the lower one to the echinus and annulets: divide the lower one into five parts, giving one to the annulets, and four to the ovolo: divide the height of the entablature into four parts, giving one to the cornice, which comprehends the distance between the fillet of the echinus or crowning moulding and the un-

der side of the guttæ; divide the remaining three into two equal parts, giving one to the height of the frize, as seen in front, and one to the architrave.

The Doric order was the only order known in Greece, or its colonies, anterior to the Macedonian conquest. The Ionic succeeded, and appears to have been the favourite order, not only in Ionia, but all over Asia Minor. The Corinthian (says Mr. Wood) came next in vogue, and most of the buildings of this order seem posterior to the time of the conquest of those countries by the Romans. The first Doric building was the temple of Juno, erected by Dorus, king of Achaia, and Peloponnesus in the ancient city of Argos, from whom this order derives its name. It was also used in other cities of this Prince's dominions, but its proportions were not established, till an Athenian colony erected a temple to Apollo Panionos, in Ionia, so called from Ion, their leader, after the form of the temples they had seen in Achaia. In this building the relative dimensions of the columns were adjusted, from the ratio which the foot of a man bears to his height, making their diameter one sixth part of their altitude.

Ionic Order. The ambitious desire of novelty soon led the way to the invention of another species; and, in erecting the temple of Diana, they sought a new order from similar traces, imitating the proportion and dress of women. The diameter of the columns was made an eighth part of their height; the base was made with folds representing the shoe; the capitals with volutes, in form of the curled hair worn upon the right and left; and the cymatium, for the locks pending on the forehead from the crown. This new order they called Ionic, after the name of the country in which it was invented: so far we are informed by Vitruvius. It is probable, that in erecting this temple the triglyphs and mutules, the bold characteristic marks of the original hut, would be omitted, and the more delicate dentils, representing the ends of the lath to which the tyles were fixed, employed, representing a beautiful row of teeth; for in all the ancient Ionian fragments of this order we find the cornices constantly denticulated, and therefore the dentils are no less characteristic marks than the capitals: they are generally omitted, however, in the remains of those to be found at Athens. The other parts and proportions of the Ionian order are more arbitrary than in the Dorian. The parts of the Ionic order on the temple by the Ilyssus are few, and of a bold character; the height of the volutes is three-fifths, and the whole height of the capital two-thirds, of the diameter of the column.

The architrave consists of one broad facia, and its crowning cymatium: the parts of the cornice as seen in front are the corona, including its cymatium, and sima. The capital, or cymatium of the frize, is wrought under the cornice, and consists of a sima reversa, and bead below it. The height of the architrave is about two-fifths of the entablature; and by dividing the upper three-fifths again into five parts, the plain part of the frize will occupy three parts, and the cornice two parts.

In the Ionic order of the temple of Erechtheus, and of the temple of Minerva Polias, the architrave consists of three faciæ, and cymatium; the cymatium of the frize is mostly wrought under the corona. If the height of the entablature from the bottom of the lower facia to the top of the cymatium of the corona be divided into nineteen parts, the architrave and the part of the frize that is seen will each be eight parts, and the corona, including the larimer and cymatium, the other three parts. The volutes of the capitals of these orders, both for singularity and beauty, exceed every other remain of antiquity.

The Asiatic Ionian order differs greatly from the Attic one. In most of the remains of this order, as represented in the Ionian antiquities, the frizes are all wanting, except in one example, and consequently the whole height of the entablatures of those without the frizes cannot be ascertained, though the architraves and cornices belonging to each other have been accurately measured. The one which has the entire entablature belongs to the great theatre at Laodicea: the frize is pulvinated, and is something less in height than one-fifth of that of the entablature. The architraves of the temple of Bacchus at Teos, and the temple of Minerva Polias at Priene, are each divided into three facæ below the cymatium. In all the Asiatic Ionics the crowning moulding is constantly a sima recta, of a less projection than it has height: the dentils are never omitted, and their height is nearly a mean proportion between the height of the sima recta and that of the larimer, corona, or drip, being always greater than the height of the corona, and less than that of the sima recta. The cymatium of the denticulated band is wrought

almost entirely out of the soffit of the corona, or recessed upwards, and consequently its elevation is almost concealed. The height of the cornice from the top of the sima to the lower edge of the dentils is equal, or very nearly so, to that of the architrave. The altitude of the frize without its cymatium, or upper mouldings, may be supposed to be about a fourth part of the whole entablature; for if higher than this, the entablature would be too great a portion of the columns for any analogy we are acquainted with. In point of beautiful proportions and elegant decorations, the entablatures of these two last examples exceed every other remain; and though their proportions are very different from those remaining at Athens, yet they are still pleasing.

In all the Grecian Ionics there seems to be a constant ratio between the upper part of the cornice, from the lower edge of the corona upwards, and the height of the entablature: this is nearly as two to nine. If these members were regulated in any other manner, their breadths would be so variable as sometimes to be so diminutive that their forms could not be perceived, and at other times so enlarged, as to overload the whole when viewed from a proper station. Indeed the great recess of the mouldings under the corona makes this a very distinct division, and on this account we never think the cornice too clumsy, though the whole denticulated band and cymatium of the frize are introduced below the cornice, which seems to be the reason of so great an apparent difference between the Asiatic and Attic Ionics. This order, as found in the Ionian territory, is complete; but those at Athens are deficient, from their want of the dentil band, though beautiful in many other respects.

Moderns have added a diameter to the height of the Ionic column, making it nine instead of eight. The shaft is generally striated into twenty-four flutes, and as many fillets. The height of the entablature in general may be two diameters; but where grandeur as well as elegance is required it should not be less than a fourth. The base employed in the Athenian Ionics consists of two tori, and a scotia or trochilus between them, and two fillets, each separating the Scotia from the torus above and below: the fillet above the torus generally projects as far as the extremity of the upper torus, and the lower fillet beyond the upper torus; the scotia is very flat, and its section an elliptic curve joining the fillet on each side: the tori and scotia are nearly of equal heights: in the Ionic temple on the Ilyssus a bead and fillet are employed above the upper torus, joining the fillet to the scape of the column: the upper torus of the basis of the same temple, and that of the basis of the temple of Erechteus, are both fluted, preserving the lower part that joins the upper surface of the fillet above the scotia entire. The upper scotia of the temple of Minerva Polias is enriched with a beautiful guilloche. The lower torus of the base of the antæ of the temple of Erectheus is receded, and that of the base of the antæ of the temple of Minerva Polias is channelled with flutes, separated from each other by two small cylindric mouldings of a quadrantal section, having their convexities joining each other. This form of a base is by Vitruvius very properly called the Attic base, being invented and employed by the Athenians in all their Ionics. It was also adopted by the Romans, and seems to have been their most favourite base; for it is not only employed in all the examples of this order at Rome, but most frequently in the Corinthian and Composite orders also. However, the proportions of the Attic base as employed by the Romans are different from that employed by the Greeks, the upper torus of the former being always of a less height than the lower one, both tori plain, and the scotia containing a much deeper cavity. The proportion of the bases of the Ionic and Corinthian orders on the Coliseum, the Ionic on the theatre of Marcellus, and that on the temple of Fortuna Virilis at Rome, have nearly that assigned by Vitruvius. The Ionic bases, as employed in the temple of Minerva Polias at Priene, and in that of Apollo Dedymæus near Miletus, consist of a large torus, three pair of astragals, and two scotiæ, inverted in respect of each other. The upper pair of astragals is disposed below the torus, and the scotiæ separate each pair of astragals from each other. In the temple of Minerva Polias an astragal is employed above the torus, separating it from the shaft; the torus itself is formed elliptically, and the under part of it is fluted: it has also a flute cut in the upper part near to the bead. In the temple of Apollo Dedymæus the upper torus is of a semicircular section and plain, and each bead of every pair is separated by a narrow fillet. The base of the Asiatic Ionics differs little from that which Vitruvius appropriates to this

order. In the former the scotiæ are inverted, which gives a greater variety in the profile than when both stand in the same position as in the Vitruvian base. The Ionians, besides the base which they appropriated to this order, sometimes used the Attic base also, as in the temple of Bacchus at Teos. This base seems not only to have been the most favourite one among the ancients, but is likewise so among the moderns. It is not so heavy in the upper part as that denominated Ionic; its contour is pleasing, and its general appearance elegant. In the capitals of the Athenian Ionics, and in that of Minerva Polias at Priene, the lower edge of the canal between the volutes is formed into a graceful curve, bending downward in the middle, and revolving round the spirals which form the volute upon each side. In the temple of Erectheus and Minerva Polias at Athens each volute has two channels, formed by two spiral borders, and a spiral division between them. The border which forms the exterior of the volute, and that which forms the under side of the lower canal, leaves between them a deep recess, or spiral groove, which continually diminishes in its breadth till it is entirely lost on the side of the eye. In the example of the temple of Erectheus, the column is terminated with a fillet and astragal a little below the lower edges of the volutes, and that of Minerva Polias in the same manner with a single fillet; and the colorino or neck of each is charged with beautiful honeysuckles, formed alike in alternate succession, but differing from each other in any two adjacent ones. The upper annular moulding of the column is of a semicircular section, and embellished with a guilloche. The echinus, astragal, and fillet, are common to both Grecian and Roman Ionic capitals, and the echinus is uniformly cut into eggs, surrounded with borders of angular sections, and into tongues between every two borders. The astragal is formed into a row of beads, with two small ones between every two large ones. These mouldings are cut in a similar manner in all the Roman buildings, except the Coliseum, and what relates to the taste of the foliage. In the temple of Bacchus at Teos, the great theatre at Laodicea, and in all the Roman Ionics, the channel connecting the two volutes is not formed with a border on the lower edge, but is terminated with a horizontal line, which falls a tangent to the second revolution of each volute at the commencement of this revolution. The reader will find the description of the volute among the descriptions of the plates. When columns are introduced in the flanks of a building as well as in the front, one of the capitals of each angular column is made to face both the contiguous sides of the building, with two volutes upon each side, projecting the two adjacent volutes by bending them in a concave curve towards the angle; as in the temple of Bacchus at Teos, of Minerva Polias at Priene, of Erectheus, and that on the Ilyssus at Athens, as also that of the Manly Fortune at Rome. The capitals of all the columns are sometimes made to face the four sides of the abacus alike on each side, as in the temple of Concord at Rome, from which example the Scammozzian capital was formed. The ancients employed this order in temples dedicated to Juno, Bacchus, Diana, and other deities, whose character held a medium between the severe and the effeminate; and the moderns employ it in churches consecrated to female saints in a matronal state; also in courts of justice, seminaries, libraries, and other structures which have a relation to the arts.

Corinthian Order. The invention of this order was attributed to the one Callimachus, an Athenian sculptor, who passing by the tomb of a young lady observed an acanthus growing up by the sides of a basket, which was covered with a tile and placed upon the tomb; and that the tops of the leaves were bent downwards by the resistance of the tyle; took the hint and executed some columns with foliated capitals, near Corinth, which were made still of a more slender proportion than the Ionic, imitating the figure and delicacy of virgins. Vitruvius mentions that the shafts of Corinthian columns have the same symmetry as the Ionic, and that the difference of the symmetry between the entire columns arises only from the difference of the heights of their capitals; the Ionic being one third, and the Corinthian the whole diameter of the shaft, which, therefore, makes the height of the Corinthian two thirds of a diameter more than that of the Ionic; hence, as he has allowed the Ionic to be eight diameters, the Corinthian will be eight and two thirds.

The sides of the abacus of the Corinthian capital are concave, and moulded on the fronts.

The lower part of the capital consists of two rows of leaves, and each row of eight plants; one of the upper leaves fronting each side of the abacus, and the stalk of

each leaf springing between each two lower leaves. The height of the abacus is one seventh, the upper and lower tier of leaves each two sevenths, and the branches and volutes which spring from the stalks between every two leaves in the upper row, the remaining two sevenths of the diameter. The breadth of the capital at the bottom is one, and each diagonal of the abacus two diameters of the column. Vitruvius makes no mention of obtunding the corners of the abacus, as is generally practised by the ancients as well as the moderns; we are, therefore, led to suppose that each pair of the four faces of the abacus were continued till they met in an acute angle, at each corner, as in the temple of Vesta at Rome, and the Stoa or portico at Athens; the division of the capital is the same as is frequently used by the moderns, but the entire height thereof is generally made one sixth more than the diameter of the column, and that of the entire column ten diameters. The best ancient specimens of the Corinthian order are to be collected from the Stoa, the arch of Adrian, and that most exquisite and singular specimen the monument of Lysicratus at Athens; also in the Pantheon of Agrippa, and in the three columns of the Campo Vaccino at Rome; these two, and particularly the last, are allowed to be the most complete existing examples that are to be found in all the remains of antiquity. The taste of the foliage of the Attic Corinthian differs considerably from that of the Roman: the small divisions of the leaves are more pointed, approaching nearer to the acanthus than those at Rome, which are for the most part olive; however, in other respects, the capitals themselves are very similar, except in the monument of Lysicrates.

The Corinthian capital exhibits the utmost degree of elegance, beauty, richness, and delicacy, that has ever been attained in architectural composition, though many attempts have been made to exceed it. The columns of this order do not appear to have had any appropriate entablature in the time of Vitruvius; for, in B. IV. chap. i. he informs us that both Doric and Ionic entablatures were supported by Corinthian columns, and that it was the columns alone which constituted this order, and not the entablatures; however, in the remains of Grecian and Roman antiquity, we find almost constantly Corinthian columns supporting an entablature with a peculiar species of cornice: a composition which seems to be borrowed from those of the Doric and Ionic orders. In this entablature the figure of the mutules supporting the corona is changed into the form of a console, and highly decorated; and the denticulated Ionic band with its cymatium, and also that of the frize, are introduced below the consoles; which in this application are called *modillions*. This disposition is inverting the order of the original hut, and also the description given by Vitruvius. The only example where dentils are placed above modillions, is in the second cornice of the tower of the Winds at Athens. As to the architrave and base of this order, they may be the same as those used in the Ionic; indeed the Ionic entablature itself would, on many occasions, be a very appropriate one for the Corinthian. When the columns are fluted, the number of the flutes and fillets is generally 24, as in the Ionic order.

If the entablature be enriched the shaft should be fluted, unless composed of variegated marble; for a diversity of colours confuses even a smooth surface, and if decorated, the ornament increases the confusion to a much greater degree. When the columns are within reach, so as to be liable to be damaged, the lower part of the flutes, to about one third of their height, is sometimes filled with cables, as that of the interior order of the Pantheon, with a view to strengthen the edges.

In rich work of some modern buildings, the cables are composed of reeds, husks, spiral twisted ribbands, flowers, and various other ornaments; but these niceties should only be employed in the decorations of the interior, and even then very sparingly, as their cost would be much better employed in giving majesty and grandeur to other parts of the fabric. As the cornice which has obtained the name of Corinthian consists of so many members, it will be necessary on this account to increase the whole height of the entablature more than two diameters, so as to make the members distinct, and at the same time to preserve a just proportion between the cornice, frize, and architrave; making the height of the entablature two-ninths of that of the column; but if the Ionic cornice is to be employed, or the dentils and their cymatium omitted, two diameters or a fifth of the height of the column will be sufficient. From hence the absurdity of giving too many members to the cornice will appear; as these slight columns are incapable of bearing an entablature of the same part of their height as

columns of fewer diameters are; this absurdity will more readily appear when the parts of both orders are made of the same altitudes.

The Corinthian order is appropriate for all buildings in which magnificience, elegance, and gaiety, are requisite; it was employed by the ancients in temples dedicated to Venus, Flora, Proserpine, and also to the nymphs of the fountains; being the most splendid of all the orders, and bearing the most affinity to foliages, flowers, and volutes, which suited the delicacy and elegance of these deities.

Its splendor also recommends it in the decorations of palaces, squares, galleries, theatres, banqueting-rooms, and other places consecrated to festive mirth or convivial recreation; it is likewise employed in churches dedicated to saint Mary, and other virgin saints.

Tuscan Order. There are no ancient remains of any entire order of this kind; the columns of Trajan and Antonine, and one at Constantinople, being defective from the want of their entablatures. We have the description of Vitruvius to the following purpose: the column is seven diameters in height, and is diminished at the top a fourth part of a diameter; their bases have a circular plinth, and are in height half a diameter, which is divided into two parts, giving one to the altitude of the plinth, and one to the torus. The capital has also half a diameter in height, and one in the breadth of its abacus. The height of the capital is divided into three parts, one of which is given to the plinth or abacus, one to the echinus, and the third to the hypotrachelian with the apophygis: the architrave is made with its vertical faces over the edge of the column, at the neck of the capital, in two thicknesses, in its horizontal dimension, with a space of two digits or 1½ inch between, for the admission of air to prevent the beams from rotting, and joined together with mortise and tenon. Over the beams and over the walls the mutules are projected a fourth part of the height of the columns, and antepagments are fixed to their fronts. A correct specimen of Tuscan architecture may be seen in St. Paul's, Covent Garden; the work of the most distinguished Inigo Jones. This order is proper for all rustic structures.

Roman Order. The character of this as an order is indicated by its capital; the upper part of which being an entire Ionic capital of that species, which fronts the four sides of the column alike, and the lower part consisting of two rows of leaves as in the Corinthian capital. Vitruvius speaks of various capitals derived from that of the Corinthian; but does not distinguish columns with such capitals supporting an entablature by the name of an order; indeed, he expressly says that they do not belong to any species of columns. Serlio was the first who added a fifth order by compounding columns similar to that of the Arch of Titus, with the entablature of the uppermost order of the Coloseum. More recent authors have, for the greater part, either adopted the entablature of the frontispiece of Nero, which was supported by Corinthian columns, or have brought in adventitious parts of other orders, by introducing the denticulated band of the Ionic with its cymatium between the modillions and the cymatium of the frize. It is something remarkable that the columns of Roman buildings, with compounded capitals, support for the greater part, Corinthian entablatures: the columns of the arches of Septimius Severus, and of the Goldsmiths, support Ionic entablatures; and those of the temple of Bacchus even support an entablature with what we now call a Tuscan cornice. In short Rome affords no example of a Composite order, with a similar cornice to any one found in the works of any distinguished modern author, except Vignola who crowns his entablature with a bold Ionic cornice. The capital of this order is more bold and massive in its parts than that of the Corinthian, the proportion of the other members should be corresponding thereto, and therefore more appropriate cornice than that of the frontispiece of Nero can hardly be applied: the modillions are very characteristic, but the denticulated band, shewn in a modern work, should be omitted, and for this reason also the shaft of the columns should be a medium between those of the Ionic and Corinthian, though the very reverse has been assigned to it.

The medallions employed in this order differ from the Corinthian: they are more massy, being composed of two faces, and a cymatium like an architrave. The Romans decorated their Composite capitals with acanthus leaves, and the same practice is followed by the moderns. The proportions will be fully understood in those of the Ionic and Corinthian orders. It is probable that the Romans employed the Composite order in their triumphal arches, and other buildings, to commemorate their vic-

tories, and to shew their dominion over those whom they conquered; and for this purpose also it may be employed in modern structures to celebrate the achievements of conquerors and virtues of legislators.

PRINCIPLES OF BUILDING

Are those parts of geometry, mechanics, mensuration, and chemistry, which shew how to design and construct the parts of a building so as to be the most durable, the destination, situation, and other fixed data of the intended structure being known. These parts of the sciences are the foundation of the art of construction.

Construction may in general be divided into two parts, the science of masonry, and that of carpentry; though there are other branches, as slatery, plumbry, &c. sometimes also employed as constituent parts; but these may be considered as rather adventitious.

The science of masonry shews how to construct walls and vaults. A wall should be built so as to resist a given force, either acting uniformly over the whole, or partially upon the surface: such as to resist the pressure of vaults or roofs unrestrained from the want of tie beams, acting along one continued buttment, as in plain vaulting; or to resist different forces, acting at intermitted points, as in groin vaulting; or to resist the force of the wind acting uniformly over the whole surface. An arch should be so constructed as to balance itself equally on all parts of the intrados, whether it be of uniform thickness, or to support a given load.

The science of carpentry comprehends the sizing, cutting, disposition, and joining of timbers. By chemistry we are enabled to judge of the quality of materials, such as stone, mortar, wood, iron, slate, lead, &c.

Taste. Taste consists in introducing such forms in the construction and embellishments, as appear agreeable to the eye of the beholder. The arrangement of the plan, figure of rooms, and contour of the whole building, and character, as to its destined purpose, depend much on taste.

Invention. Invention is the art of combining or arranging the various apartments in the most convenient order.

Basements. A basement is the lower story of a building on which an order is placed; its height will therefore be variable, according as it is the cellar story or the ground story; or, when it is the ground story, according as there are principal rooms in both stories or only in one of them. It is proper, however, to make the basement no higher than the order of the next story; for this would be making the base more principal in the composition, than the body to be supported. If the cellar story is the basement, and if the height does not exceed five or six feet at the most, it may be plain, or with rustics, or formed into a continued pedestal; but if the basement is on the ground story, the usual manner of decorating it is with rustics supported on a base, and surmounted with a crowning string-course: the base may either be a plinth alone, or with mouldings over it: in like manner the string-course may either be a plat-band or with mouldings under it; or it may form a cornice. The rustics are either made of a rectangular, or triangular section, by imagining one of the sides of these sections to be a line extending across the front of the joint. The joints of the rustics may be from an eighth to a tenth part of their height. The depth of the joint of the triangular rustic may be half of its breadth, that is, making the two planes by which it is formed a right angle, and the depth of the rectangular-sectioned rustics from one-fourth to one-third of their breadth. The ancients always marked both directions of the joints of the rustics; whereas the moderns not only employ the ancient manner, but they sometimes make them with horizontal joints alone. Those with horizontal joints represent rather a boarded surface than that of a stone wall, which must have two directions of joints. The height of the string-course should not exceed the height of a rustic with its joint: the plinth, or zocholo, ought not to be less than the height of the string-course. When the basement is perforated with arcades, the imposts of the arches may be a plat-band, which may be equal to the height of a rustic, exclusive of the joint. When the string-course is a cornice, the base may be moulded, and the projection of the cornice may be two-thirds of its height; so as to be less prominent than that which finishes the building. The height of the cornice may be about one-eighteenth part of the height of the basement, and that of the base about twice as much, divided into six parts, of which, the lower five-sixths form the plinth, and the upper sixth the mouldings.

Pedestals. A pedestal is a part of some buildings, with a base, surmounted with a rectangular prismatic solid, called the die, and this die again crowned with a cornice, for supporting a colonade, or pilastrade, or sometimes for supporting the upper part of

a building as a basement. In the buildings of the Greeks pedestals never obtained: the columns of their temples generally stood on the uppermost of three steps; indeed there is no existing example with any other number than three, except the temple of Theseus at Athens, which had only two, and was supposed to have been erected to an inferior deity: whatever innovations took place, were after Greece lost its independence. The Romans in many of their temples and other edifices, raised the floors so very high, that they were under the necessity of discontinuing the front stairs, which otherwise would have been found inconvenient, in occupying too much ground around the edifice; and of adopting a pedestal, or podium, as a basement; which was raised as high as the stair, and projected to the front of the steps which profiled on the sides of the pedestal.

It is remarkable that Vitruvius, in treating of the Doric, Corinthian, and Tuscan orders, never mentions a pedestal; and in treating of the Ionic, he only speaks of it as a necessary part of the construction, and not as part of the order: several modern writers are also of this opinion.

It must be confessed, wherever pedestals are introduced, the grandeur of the order is diminished, as all the parts are proportionably less; however there are some situations in which they are indispensably necessary, as in the interior of churches, where, if they were omitted, the beauty of the columns would be entirely lost, as so great a portion of them would be concealed by the pews. The proportions of pedestals in the ancient Roman buildings are very variable; modern authors however, have thought proper to bring them to a standard ratio, which Vignola makes one third of the height of the column; but as this proportion oppeared to make them too high, Sir William Chambers reduced it to three-tenths; these ratios, however, might vary as particular circumstances might require. The parts of pedestals may be thus proportioned: divide the height into nine equal parts, give one to the cornice, two to the base, and six to the die. The plan of the die is the same as that of the plinth of the column; the projection of the cornice may be equal to its height: the base may be divided into three parts, giving two to the plinth, and one to the mouldings; which in most cases may project equal to their height. These proportions are common to all pedestals. It is sometimes customary to adorn the dies of pedestals with sunk pannels, surrounded with mouldings: the pannels are frequently charged with bas reliefs or inscriptions. Projecting tablets should never be admitted, as they are not only clumsy, but confuse the contour. The dies of the pedestals of the arches of Septimius Severus and Constantine have straight-headed niches with statues. Pedestals should never be insulated, though the columns which stand upon them were insulated. In the theatres and amphitheatres of the ancients pedestals were used in all the superior orders, while the inferior order stood upon steps. They were employed for the purpose of forming a parapet for the spectators to lean over, and for raising the base of the superior order so high, as to be seen upon a near approach to the building. In these situations the pedestals were made no higher than to prevent accidents. When pedestals are continued with breaks under the columns, or pilasters in ancient buildings; the breaks were called stylobatæ; and the recess between every two stylobatæ, the podium, which had the same parts disposed at the same levels as the stylobatæ.

Arcades. An arcade is an aperture in a wall with an arched head; which term is also sometimes applied in the plural number to a range of apertures with arched heads. When an aperture is so large that it cannot be lintelled, it then becomes necessary to arch it over. Arcades are not so magnificent as colonades, but they are stronger, more solid, and less expensive. In arcades the utmost care should be taken of the piers, that they be sufficiently strong to resist the pressure of the arches, particularly those at the extremes. The Romans employed them in their triumphal arches, and many other buildings. Arcades may be used with propriety in the gates of cities, of palaces, of gardens, and of parks; they are much employed in the piazzas, or squares of Italian cities; and in general are of great use, in affording both shade and shelter in hot and rainy climates; but, on the contrary, they are a great nuisance to the inhabitants, as they darken their apartments, and serve to harbour idle and noisy vagabonds. Lofty arcades may be employed with great propriety in the courts of palaces, and noblemen's houses. There are various ways of decorating the piers of arcades, as with rustics, columns, pilasters, caryatides, persians, or terms surmounted with appropriate entablatures; and some-

times the piers are even so broad, as to admit of niches. The arch is either surrounded with rustic work, or with an archivolt; sometimes interrupted at the summit with a key-stone in the form of a console, or marsh, or some other appropriate sculptured ornament. The archivolt rises sometimes from a plat-band, or impost, placed on the top of the piers; and at other times from an entablature, supported by columns on each side of the arch. In some instances, the arches of arcades are supported entirely by single or coupled columns, without the entablature; as in the temple of Faunus at Rome. This form is far from being agreeable to the eye; it wants stability, as the columns would be incapable of resisting the lateral pressure of the arches, were they not placed within another walled inclosure, or in a circular colonade. In large arches the key-stones should never be omitted, and should be carried to the soffit of the architrave, where they will be useful in supporting the middle of the entablature, which otherwise would have too great a bearing.

When columns are detached, as in the triumphal arches of Septimius Severus, and Constantine, at Rome, it becomes necessary to break the entablature, making its projection over the intercolumns, the same as if pilasters had been used instead of columns; or so much as is just sufficient to relieve it from the naked of the wall. This is necessary in all intercolumns of great width, but should be practised as little as possible, as it destroys the genuine use of the entablature. When columns are without pedestals, they should stand upon a plinth, in order to keep the bases dry and clean, and prevent them from being broken.

Arcades should never be much more, nor much less, than double their breadth. The breadth of the pier should seldom exceed two-thirds, nor be less than one-third of that of the arcade; and the angular pier should have an addition of a third, or a half, as the nature of the design may require. The impost should not be more than one-seventh, nor less than a ninth, of the breadth of the arch; and the archivolt not more than one-eighth, nor less than one-tenth, of that breadth. The breadth of the bottom of the key-stone should be equal to that of the archivolt; and its length not less than one and a half of its bottom breadth, nor more than double. In groined porticos, the thickness of the piers depends on the width of the portico, and the superincumbent building; but with respect to the beauty of the building, it should not be less than one quarter, nor more than one-third, of the breadth of the arcade. When the arcades form blank recesses, the backs of which are pierced with doors or windows, or recessed with niches, the recesses should be at least so deep, as to keep the most prominent parts of the dressings entirely within their surface. In the upper stories of the theatres and amphitheatres of the Romans, the arcades stood upon the podia, or inter-pedestals, of the columns; perhaps as much for the purpose of proportioning the apertures, as to form a proper parapet for leaning over.

Colonades. A colonade is a range of attached or insulated columns, supporting an entablature. The interval between the columns, measured by the inferior diameter of the column, is called the intercolumniation; and the whole area between every two columns is called an intercolumn. When the intercolumniation is one diameter and a half, it is called pycnostyle, or columns thick set; when two diameters, systyle; when two and a quarter, eustyle; when three, diastyle; and when four, aræostyle, or columns thin set. A colonade is also named according to the number of columns which support the entablature, or fastigium: when there are four columns, it is called tetrastyle; when six, hexastyle; when eight, octostyle; and when ten, decastyle. The intercolumniations of the Doric order are regulated by the number of triglyphs, placing one over every intermediate column; when there is one triglyph over the interval, it is called monotriglyph; when there are two, it is called ditriglyph; and so on, according to the progressive order of the Greek numerals. The intercolumniation of the Grecian Doric is almost constantly the monotriglyph: from this practice there are only two deviations to be met with at Athens, the one in the Doric Portico, and the other in the Propylæa; but these intervals only belong to the middle intercolumniations, which are both ditriglyph, and became necessary, on account of their being opposite to the principal entrances. As the character of the Grecian Doric is more massy and dignified than that of the Roman, the monotriglyphic succeeds best; but in the Roman it is not so convenient, for the passage through the intercolumns would be too narrow, particularly in small buildings; the ditri-

glyph is therefore more generally adopted. The aræostyle is only applied to rustic structures of Tuscan intercolumniations, where the columns are lintelled with wooden architraves.

When the solid part of the masonry of a range of arcades are decorated with the orders, the intercolumns become necessarily wide; and the intercolumniation is regulated by the breadth of the arcades, and that of the piers.

It does not appear that coupled, grouped, or clustered columns, ever obtained in the works of the ancients; though, on many occasions they would have been much more useful: we indeed find, in the temple of Bacchus at Rome, columns standing as it were in pairs; but as each pair is only placed in the thickness of the wall, and not in the front, they may rather be said to be two rows of columns, one almost immediately behind the other. In the baths of Dioclesian, and in the temple of Peace at Rome, we find groined ceilings, sustained by single Corinthian columns; a support both meagre and inadequate. Vignola uses the same intercolumniation in all his orders: this practice, though condemned by some, is founded upon a good principle; it preserves a constant ratio between the columns and the intervals.

Of all the kinds of intercolumniation, the custyle was in the most general request among the ancients; and though in modern architecture both the custyle and diastyle are employed, yet the former of these is still preferred in most cases: as to the pycnostyle interval, it is frequently rejected for want of room, and the aræostyle, for want of giving sufficient support to the entablature.

The moderns seldom employ more than one row of columns, either in external or internal colonades; for the back range destroys the perspective regularity of the front range: the visual rays, coming from both ranges, produce nothing but confusion in the eye of the spectator. This confusion, in a certain degree, also attends pilasters placed behind a row of insulated columns: but in this the relief is stronger, owing to the rotundity of the column, and the flat surfaces of the pilasters. When buildings are executed on a small scale, as is frequently the case of temples, and of other inventions used for the ornaments of gardens, it will be found necessary to make the intercolumniations, or at least the central one, broader than usual, in proportion to the diameter of the columns; for, when the columns are placed nearer each other than three feet, the space becomes too narrow to admit persons of a corpulent habit.

Pilasters and Antæ. Pilasters are rectangular prismatic projections, advancing from the naked part of a wall, with bases and capitals like columns, and with an entablature supported by the columns; hence they differ from columns, in their horizontal sections being rectangles, whereas those of columns are circles, or the segments of circles, equal to or greater than semicircles.

It is probable that pilasters are of a Roman invention, since there are but few instances in Grecian buildings where they are repeated at equal or regular intervals, and these only in the latter ages of Greece, as in the monument of Philopapus; (unless in that of Thrasyllus) but of their application in Roman works there are numberless instances: Vitruvius calls them parastatæ. The Greeks used a kind of square pillars only upon the ends of their walls, which they called antæ, which antæ projected sometimes to a considerable distance from the wall of the principal front, and formed the pronaos or vestibulum. The breadth of the antæ on the flanks of the temples was always considerably less than on the front: these antæ had sometimes columns between them, and when this was the case, the return within the pronaos was of equal breadth to the front. The capitals of the antæ never correspond with those of columns, though there are always some characteristic marks, by which the order may be distinguished.

Pilasters, or parastatæ, when ranged with columns under the same entablature, or placed behind a row of columns, have their bases and capitals like those of the columns, with the corresponding parts at the same heights, and when placed upon the angles of buildings, the breadth of the returns is the same as that of the front. The trunks of pilasters have frequently the same diminution as the shafts of the columns, such as in the arches of Septimius Severus, and Constantine, and in the frontispiece of Nero, and the temple of Mars the Avenger, at Rome; in this case, the top of the trunks of the pilasters is equal to the breadth of the soffit of the architrave, and the upright face of the architrave resting on the capital, in the same perpendicular as the top of the pilaster. When the pilasters are undiminished, and of the same breadth as the co-

lumns at the bottom, the face of the architrave resting on the capital retreats within the top of the trunk, as in the Pantheon of Agrippa.

Pilasters are either plain or fluted. In ancient edifices this was not always regulated by the columns, but perhaps depended on the taste of the architects, or destination of the edifice. The columns are plain on the portico of the Pantheon, while the pilasters are fluted; and the contrary, on the portico of Septimius Severus. When pilasters are fluted, the angles or quoins are frequently beaded, such as those of the Pantheon, in order to strengthen the angles, and the flutes are generally of a semicircular section. The faces of pilasters are sometimes sunk within a margin, and the pannels charged with foliage, arabesque, or grotesque ornaments, or instruments of music and war, or sometimes these compounded, according to the destined purpose of the place in which they are employed.

The pannels of the pilasters, in the Arch of the Goldsmiths at Rome, are charged with winding foliage and trophies of war. Pilasters, when placed on the front or outside of a building, should project one quarter of their breadth at the bottom; but when placed behind a range of columns, or in the interior of a building, should not project more than the eighth part of the same breadth.

In a large recess, when two or any even number of insulated columns support an entablature, which terminates at each end upon a wall or pier, a pilaster is most commonly placed against each wall or pier, to support the extremities of the architrave. When the entablature over the columns is recessed within the surface of the wall or pier at each end, the pilaster projects towards the column, its thickness is shewn on the front, and its breadth faces the void or adjacent column: in this case the architrave may either profile against the sides of the aperture or recess, or it may return at each interior angle, and then again at the exterior angles, and proceed along each wall or piers.

If the intermediate columns and extreme pilasters are so ranged as to project a small distance beyond the face of the wall at each end, the pilasters shew the same breadth towards the front as towards the void, and the entablature may be continued unbroken, as in the chapels of the Pantheon, and if it breaks it must be at the extreme or most distant angles. Pilasters are of great strength to a wall, as well as ornamental to the building; they are less expensive than columns, and in situations where they are either placed behind a range of columns, or support the extremes of an entablature across an opening, they are more concordant with the walls to which they are attached.

Clustered pilasters, or those which have both exterior and interior angles, and the planes of those angles parallel and perpendicular to the front, may be executed with good effect, when the order is plain, as in the Tuscan: but in the three Grecian and Composite orders, this junction should be avoided as much as possible, because the triglyphs and capitals of these orders always meet imperfectly in the interior angles. The same may also be said of Ionic and Corinthian capitals of half pilasters, meeting each other in the interior angles of rooms. In the Ionic order it becomes necessary to make a difference between the capitals of pilasters and those of columns; for, in the capitals of the columns the projection of the ovolo is greater than that of the volutes; but as the horizontal section of the ovolo is circular, the ovolo itself is bent behind the hem or border of the volutes: now supposing a vertical section through the axis of the column to be perpendicular to the face, and another through the middle of the breadth of the pilaster, and that the corresponding mouldings are equal and similar in both sections; then, because the horizontal section through the ovolo is rectangular, as in the trunk, the ovolo would, if continued, pass over the volutes, or must terminate abruptly and shew the profile of the moulding, which is a palpable defect. This therefore renders it necessary to give the ovolo so much convexity on the front, as to make its extremes retire, and pass behind the back of the border of the volutes; or to make the ovolo of small projection; or to twist the volutes from a plain surface, which the ancient Ionic has, and make every part of the spirals project more and more towards the eye; or lastly, to project the whole abacus, with the volutes, beyond the projection of the ovolo. The same thing is also to be observed with regard to the Corinthian and Composite capitals, where the upper part of the vase projects beyond the middle of the abacus, and would, in the pilaster capitals, pass over the faces of the spirals or volutes.

Persians and Caryatides. Instead of columns, or pilasters, it is sometimes customary to support the entablature by human figures; the males of which are called Persians, Talamones, or Atlantides; and the females, Carians, or Caryatides. The history of these Vitruvius relates as follows: "Caria, a city of Peloponnesus, having joined with the Persians against the Grecian states, and the Greeks having put an end to the war, by a glorious victory, with one consent declared war against the Caryatides. They took the city, destroyed it, slew the men, and led the matrons into captivity, not permitting them to wear the habits and ornaments of their sex; and they were not only led in triumph, but were loaded with scorn and kept in continual servitude; thus suffering for the crimes of their city. The architects therefore of those days introduced their effigies sustaining weights, in the public buildings, that the remembrance of the crime of the Caryatides might be transmitted to posterity. The Lacedæmonians likewise, under the command of Pausanias, the son of Cleombrotus, having at the battle of Platea, with a small number, vanquished a numerous army of Persians; to solemnize the triumph, erected with the spoils and plunder the Persian Portico, as a trophy, to transmit to posterity the valour und honour of the citizens; introducing therein the statues of the captives, adorned with habits in the barbarian manner supporting the roof."

There can be little doubt but that human figures, and those of inferior animals, had a very early introduction in architecture, and are of more remote antiquity than that assigned by Vitruvius; for we are informed by Diodorus Siculus, that in the sepulchre of Osymanduas there was a stone hall four hundred feet square, the roof of which was supported by animals instead of pillars: the number of these supports is not mentioned. The roofs of several Indian buildings, supposed of the most remote antiquity, are sustained in the same manner. In Denon's travels in Egypt, among other fragments, are represented five insulated pilasters or pillars, bearing an entablature: the fronts of the pillars are decorated with priests or divinities. The molten sea, recorded in Holy Writ, was supported by twelve bulls. In the Odyssey of Homer, translated by Pope (book vii. ver. 118,) we find the effigies of animals, both rational and irrational, employed as decorations, which appears by the following extract.

Two rows of stately *dogs*, on either hand,
In sculptur'd gold, and labour'd silver stand.
These Vulcan form'd with art divine, to wait
Immortal guardians at Alcinous' gate;
Alive each animated frame appears,
And still to live beyond the power of years.
Fair thrones within from space to space were rais'd,
Where various carpets with embroidery blaz'd,
The work of matrons: these the princess prest,
Day following day, a long continu'd feast,
Refulgent pedestals the walls surround,
Which *boys* of gold with flaming torches crown'd.

However these representations of animals were not employed as columns to support an entablature, but merely as ornaments.

In Stewart's antiquities of Athens, we find a most beautiful specimen of Caryatic figures, supporting an entablature, consisting of an architrave cornice of a very elegant profile. Among the Roman antiquities, there are likewise to be found various fragments of male figures, which may be conjectured from their attitudes, and ornaments, to have been the supports of the entablatures of buildings.

Besides Persians and Caryatides, it is sometimes customary to support the entablatures with figures, of which the upper part is the head and breast of the human body, and the lower part an inverted frustrum of a square pyramid, with the feet sometimes projecting out below, as if the body had been partly cased: figures of this form are called terms or termini, which owe their origin to the stones used by the ancients in marking out the limits of property belonging to individuals. Numa Pompilius, in order to render these boundaries sacred, converted the Terminus into a deity, and built a temple on the Tarpeian Mount, which was dedicated to him, whom he represented by a stone, which, in course of time, was sculptured into the form of a human head and shoulders, and other parts, as has already been defined. He was on particular occasions adorned with garlands, with which he appeared of a very pleasant figure. Persian figures are generally charged with a Doric entablature; Caryatic figures

with Ionic or Corinthian, or with an Ionic architrave cornice; and the Termini with an entablature of any of the three Grecian orders, according as they themselves are decorated. Male figures may be introduced with propriety in arsenals or galleries of armour; in guard rooms, and other military places, where they might represent the figures of captives, or else of martial virtues, such as Strength, Valour, Wisdom, Prudence, Fortitude, and the like. As these figures should be of a striking character, they may be of any colossal size that will agree with the architecture of the other parts of the buildings. In composing Caryatides, the most graceful attitudes and pleasant features should be chosen: and to prevent stiffness, their drapery and features should be varied from each other, in the different figures of the range; yet a general form of figure should be preserved throughout the whole of them.

Caryatides should always be of a moderate size, otherwise they might appear hideous to the fair sex, and destroy those endearments, so fascinating in the sex represented by them. They may be employed, as Le Clerc observes, to sustain the covering of a throne, and represented under the figures and symbols of heroic virtues: if to adorn a sacred building, they must have an affinity to religion; and when placed in banqueting rooms, ball-rooms, or other apartments of recreation, they should be of kinds proper to inspire mirth and promote festivity. As Termini are susceptible of a variety of decorations, they may be employed as embellishments for gardens and fields, representing Jupiter as protector of boundaries, or some of the rural deities, as Pan, Flora, Pomona, Vertumnus, Ceres, Priapus, Faunus, Sylvanus, Nymphs, and Satyrs.

They are also much employed in chimney-pieces, and other interior compositions.

Orders above Orders. When two or more orders are placed one above the other, the laws of solidity require that the strongest should be placed lowermost; and also, that their axes should be in the same vertical lines. When the columns of the orders are of the same diameter, their altitudes increase from the Tuscan, Doric, and Ionic to the Corinthian, and consequently in this progression: the Tuscan is stronger than the Doric, the Doric stronger than the Ionic, and the Ionic stronger than the Corinthian; therefore if the Doric be the lowest order, the Ionic is the succeeding order; and if there be a third order, the Corinthian is in consequence the next. But since the different stories of a building should rather be of a decreasing progression upwards than even of an equal altitude to each other, it follows that the superior columns should not only be diminished in order to lessen the insisting weight from the inferior, but also to accommodate the heights of windows.

The rule given by Vitruvius (b. v. c. 7.) for placing one order above another, is to make the columns of the superior order a fourth part less in height than those of the inferior.

Scamozzi's rule is to make the diameter at the bottom of the shaft of the superior order equal to the upper diameter of the inferior order.

Let us now suppose that the Ionic of nine diameters is to be raised upon the Doric of eight diameters as in the Roman Doric; according to the rule given by Vitruvius, the bottom diameter of the Ionic will be $\frac{2}{3}$ of that of the Doric, a quantity much less than is to be found in any ancient or modern example of the diminution of the Doric shaft; which diminution is the lower diameter of the superior order by Scamozzi's rule.

In insulated columns, when the diminution of the superior order is very great, the intercolumn becomes so wide, and the entablature so small, and consequently weaker, that it is in danger of breaking; and if a third range is added, this defect must be increased. The Vitruvian rule is therefore not so applicable as the Scamozzian, which, for the above reasons, is universally esteemed the best, and is the same as if the several shafts had been cut out from one long tapering tree; on the other hand, when the diminution of the inferior diameter of the superior order is too little or nothing, the columns will not only be too high for the windows, but the lower order will be loaded with unnecessary weight. Let the stronger order be made the superior; for example, let the Doric be placed upon the Ionic, and allowing the shaft of it to diminish five-sixths of its bottom diameter, the height of the Doric column will be only $6\frac{2}{3}$ diameters of the Ionic below: this would not only make a complete Attic of the Doric, but would render the application of the orders in this inverted way useless, as they could not be made to accommodate the stories of the building, nor could the upper ranges sup-

port their own entablatures, which must be the consequence in insulated columns.

When the front of a building is to have two or more orders in the altitude, the succession ought to be complete, otherwise the harmony will be destroyed by the violent contrast of the parts. When columns are attached, a recedure of the superior order will not offend the eye in any great degree, nor will the solidity of the structure be impaired: this is to be seen in the theatre of Marcellus; but when the stories of orders are insulated, it is necessary that the axis of the superior and inferior columns should be in the same vertical lines. If the upper order only insists in the middle of that below in two equidistant parts from the middle, the portions of the entablature of the lower order in which there is no superior order are generally finished with a balustrade, level with the sills of the windows.

In England we have few examples of more than two ranges of columns in the same front; for when there are three, it is difficult to preserve the character of each order in the intercolumnial decorations, without some striking defects. The first and second orders should stand upon a plinth, and the third also when there is one; the point of view regulating the two upper plinths. In this case pedestals should be omitted in the upper orders, and if there is one, or a balustrade under the windows, the base and cornice should have but a small projection, and should be continued to profile upon the sides of the columns. In raising stories of arcades upon each other, with orders decorating the piers, the inferior columns should be placed upon a plinth, and the superior ones upon a pedestal, in order that the arches may obtain a just proportion.

Pediments. A pediment is a part of a building having a horizontal cornice below, and two equally inclined ones, or an arched cornice above, joined at the extremities of the horizontal one; the cornices including a plane surface within, called the tympanum, which is therefore either a triangle or the segment of a circle.

This definition does not comprehend every species of pediments which have been absurdly introduced; but it may be said to be the only genuine one, as pediments represent the ends of roofs, and were originally intended to discharge the rain from the middle of the building, by compelling it to descend and fall over the flanks or extremes, and not over the front, which must be the case with every other figure that can be introduced except those of a polygonal form, which present their interior angles to the horizontal cornice, or the exterior ones upwards. To find the pitch of the pediment Vitruvius directs as follows: divide between the extremities of the cymatium of the corona into nine equal parts, and one makes the height of the tympanum; but this rule is not correct, as the tympanum will vary its angles according as there are more or less mouldings of the inclined cornices within the extremities of the cymatium of the corona; for since the middle part by this rule is invariable, and the broader the parts are of the inclined cornices within each extremity of the cymatium of the corona, or rather within the under edge of the fillet of the sima upon each inclined cornice, the less is the base of the tympanum, and consequently the vertical angle, less obtuse, and the base angles less acute; but if this height extended to the meeting of the two under sides of the fillets of the sima, or crowning moulding, then the figure of the tympanum would be invariable. The Vitruvian rule has been thought by many to be too low; but it is to be recollected, that that of the Parthenon at Athens, which has an octostyle portico, is nearly of this proportion; that of the temple of Theseus, which has an hexastyle portico, is about one-eighth; that of the Ionic temple on the Ilyssus, and of the Doric portico, which are both tetrastyle, are about one-seventh; the tympanum of the pediment of the door on the Tower of the Winds is about one-fifth of the span. The edifices here mentioned are all Athenian buildings. From this comparison it would appear, that a kind of reciprocal ratio subsists between the extension of the base of the tympanum, and its height. Indeed, if a fixed ratio were applied to windows, the pediment would frequently consist of a cornice without the tympanum. It is therefore with great reason that we often make the pitch of pediments of windows more than those which crown porticos, or the fronts of buildings. The plinths by which pediments are sometimes decorated are called acroterions, or acroters: the two which present triangular faces at the extremes, have their heights, according to Vitruvius, half of that of the tympanum, and the middle one saddled on the summit is one-eighth part higher than those at the extremes. Pediments owe their origin most probably to the inclined roofs of primitive huts. Among the Romans they were only

used as coverings to their sacred buildings, till Cæsar obtained leave to cover his house with a pointed roof, after the manner of temples. In Grecian antiquity we meet only with triangular pediments, and in Roman buildings we meet with both the triangular and circular. In rows of openings, or niches, both kinds of pediments were employed in the same range, and disposed in alternate succession. The horizontal cornices of pediments should never be discontinued, as may be seen in many of the street houses of London, in order to give room for a fan light, and to lessen the expenses of the frontispiece, by introducing shorter columns and a less massy entablature: for since the horizontal cornice represents the tie-beam, and the inclined ones the rafters, the columns will appear to have a tottering effect by spreading them out at the top beyond the extremities of their bases.

Vitruvius observes, that the Greeks never used mutules, modillions, or dentils, in the front, in which the end of the roof, or fastigium, appears, because that the ends of the rafters and the ends of the laths which support the tiles only appear at the eaves of the building. Now, as mutules and dentils originated from the projecting ends of the rafters and laths, following the course of nature, it would have been absurd to introduce them into the pediment.

However just this reasoning appears, we find from the remains of Grecian antiquity this assertion only verified in the inclined cornices of the pediment: for mutules are constantly employed in the horizontal cornice; but neither mutules, modillions, nor dentils, on the sloping sides: at least, when any of the edifices in Greece appear with those innovations, they were introduced during the time it was a province of the Roman empire. Of this practice at Rome the Pantheon and the frontispiece of Nero are examples of modillions; and the temple of Fortune one where dentils are used. In the inclined cornices of pediments the sides of the modillions and dentils are planes perpendicular to the horizon and to the front of the edifice; and in the same vertical planes with those of the modillions or dentils of the horizontal cornice.

Balustrades. A balustrade is a range of small columns, called balusters, supporting a cornice, used as a parapet or as a screen to conceal the whole or a part of the roof: it is also sometimes used as a decoration for terminating the building. Balustrades are employed in parapets, on the margins of stairs, or before windows, or to inclose terraces or other elevated places of resort, or on the sides of the passage way of bridges. It is remarkable, that there are no remains of balusters to be seen in any ancient building. In the theatres and amphitheatres of the Romans the pedestals of the upper orders were always continued through the arcades, to serve as a parapet for the spectators to lean over. The lowermost seats next to the arena in the amphitheatres, and those next to the orchestra in the theatres, were guarded by a parapet or podium. The walls of ancient buildings generally terminated with the cornice itself, or with a blocking course, or with an Attic. In the monument of Lysicrates at Athens, which is a small beautiful building, the top is finished with fynials, composed of honeysuckles, solid behind, and open between each pair of fynials: each plant or fynial is bordered with a curved head, and the bottom of each interval with an inverted curve. Perhaps terminations of this nature might have been employed in many other Grecian buildings, as some coins seem to indicate; but this is the only existing example of the kind. The temples in Greece are mostly finished with the cornice itself. This was also the case with many of the Roman temples; but as there are no remains of balustrades in ancient buildings, their antiquity may be doubted: they are, however, represented in the works of the earliest Italian writers, who perhaps may have seen them in the ruins of Roman edifices. When a balustrade finishes a building, and crowns an order, its height should be proportioned to the architecture it accompanies, making it never more than four-fifths, nor less than two-thirds of the height of the order, without reckoning the zocholo, or plinth, on which it is raised, as the balustrade itself should be completely seen at a proper point of view. Balustrades that are designed for use should always be of the height of parapet walls, as they answer the same purpose, being nothing else than an ornamental parapet. This height should not exceed three feet and a half, nor be less than three feet. In the balusters, the plinth of the base, the most prominent part of the swell, and the abacus of their capital, are generally in the same straight line: their distance should not exceed half the breadth of the abacus or plinths, nor be less than one-third of this measure. On stairs or inclined planes the same proportions are to be observed as on

horizontal ones. It was formerly customary to make the mouldings of the balusters follow the inclination of the plane; but this is difficult to execute, and, when done, not very pleasant to the eye: though in ornamental iron-work, where it is confined to a general surface, passing perpendicularly by the ends of the steps, it has a very handsome appearance. The breadth of pedestals, when placed over an order, is regulated by the top of the shafts, the die being always equal thereto. When balustrades are placed upon the entablature of an order, over the intercolumns or interpilasters, and the base and cornice of the balustrade continued, so as to break out and form pedestals over the columns or pilasters; the breadth of the die of the pedestals should be equal to the breadth of the top of the shafts; and where there is no order, the breadth of the die is never more than its height, and very seldom narrower; and the dies of the pedestals are frequently flanked with half dies, particularly when the range of balusters is long. This is not only apparently necessary, but is in reality useful in shortening the range, and forming a better support for the ends of the rail.

Attics. An Attic is a part of a building standing on the cornice, similar in form to that of a pedestal; and is either broken or continued. The use of an attic is to conceal the roof, and to give greater dignity to the design. The Romans employed attics in their edifices, as may be seen in the remains of the triumphal arches, and piazza of Nerva. In the arch of Constantine pedestals are raised over the columns as high as the base of the attic, and these pedestals are again surmounted with insulated statues. In the ruins of Athens there are no attics to be found: there is one, however, over a Corinthian colonade at Thessalonia, with breaks forming dwarf pilasters over the columns; and with statues placed on front of the pilasters, as in the arch of Constantine. The attic carried round the two courts of the great temple of Balbec is also broken into dwarf pilasters over the columns and pilasters of the order; and the dwarf pilasters have blocking courses over them, on which statues are supposed to have been placed. Attics are very disproportional in the ruins of these ancient edifices; some of them being nearly one-half of the height of the order. The moderns make their height equal to that of the entablature; as to the proportion of the height of the members it may be the same as that for pedestals.

Doors. Doors are apertures in exterior walls, used for passage into public and private buildings; and in the interior for communication from one apartment to another. In the fourth book of Vitruvius rules are laid down for Doric, Ionic, and Attic doors, all of which have apertures narrower at the top than at the bottom. These trapazoidal closures of apertures have the property of shutting themselves, which, perhaps, might have occasioned the introduction of this form, and are useful in modern times for raising the door above the floor in the act of opening, in order to keep it clear of the carpet. Examples of them are to be found among the ruins of ancient edifices; they have also been introduced by a few modern architects. The apertures of doors of small dimensions are most commonly closed with lintels. Doors, in general, are regulated in their apertures by the size of a man, so as never to be smaller than that he might pass freely through them; they are seldom less than two feet nine inches in width, by six feet six inches in height, except in confined situations, and where utility is beyond any other consideration.

Doors of entrance vary in their dimensions according to the height of the story, or magnitude of the building in which they are placed. In small private houses four feet may be the greatest width, and in most cases three feet six inches will be sufficient. The lintels of doors should range with those of the windows; and the width of their aperture should not be less than that of the windows. A good proportion of doors is that where its dimensions has the ratio of three to seven; their height should never be less than twice, nor more than twice and a half their breadth. In the entrance doors of public edifices, where there is a frequent ingress and egress of people, and often crowded, their width may be from six to ten feet. Inside doors, or doors of communication, should be in some measure proportioned to the height of the stories; however, there is a certain limit for the dimensions of their apertures, which they should not exceed; for the difficulty of shutting the door will be increased by its magnitude; therefore the apertures of doors which are intended to shut in one breadth should never exceed three feet six inches. In palaces and in noblemen's houses, where much company resort, and in state apartments, all the doors are frequently thrown open: they are made much larger than other doors, being from four to six feet in width, with folding leaves. The proportion of the apertures of such

doors will often be of a less height than that of twice the breadth, as all the rooms in the same story have a communication with one another, the whole of the doors in that story will have one common height.

The apertures of exterior doors placed in blank arcades are regulated by the imposts, the top of the aperture being generally made level with the springing of the arch; or if the door has dressings which include a cornice, the top of the cornice ought to be on the same level with the springing of the arch. With regard to the situation of the principal entrance, it is evident that the door should be in the middle, as it is not only more symmetrical, but will communicate more easily with all the parts of the building. In principal rooms doors of communication should at least be two feet distant from the walls if possible, that furniture may be placed close to the door-side of the room. The most common method of adorning doors is with an architrave surrounding the sides of the aperture, or with the architrave surmounted with a cornice forming an architrave cornice, or with the architrave frize and cornice forming a complete entablature. Sometimes the ends of the cornice are supported with consoles, placed one on each side of the architrave; and each console is most commonly attached to the head of a pilaster; sometimes the surrounding architrave is flanked with pilasters of the orders, or of some other analogical form. In this case, the projections of their bases and capitals are always within that of the architrave: the architrave over the capitals of the pilasters is the same as that of the head of the door, and the parts exactly of the same height, and projections profiling upon the sides of the surrounding architrave. Sometimes, either with or without these dressings, the door is also adorned with one of the five orders, or with columns supporting a regular entablature, frequently surmounted with a pediment. Doors are also sometimes adorned with rustics, which may either be smooth, hatched, frosted, or vermiculated; but their outline must be sharp. The rustics are disposed in contiguity with each other, or are repeated by equal intervals: as to the shafts of columns the rustic cinctures may either be cylindrical or with rectangular faces. In doors with rectangular apertures and rusticated heads, the rustics are drawn from the vertex of an equilateral triangle within the aperture. The entrance doors of grand houses are often adorned with porticos, frequently in the manner of Grecian temples; sometimes the plan of the portico may be circular, which should never have less than three intercolumniations, as the entablature would appear to overhang its base, in such a degree as to offend the eye of a beholder.

Windows. A window is an aperture in a wall for the admission of light. The size of windows depends on the climate, the aspect, the cubature, the proportion, the destination, and the thickness of the walls of the place to be lighted; as also on the number and distribution of windows in that place. It is not very easy, even with these data, to determine, with mathematical exactness, the necessary quantity of light; but in private houses, were beauty and proportion are required, the width of windows depends on the height of the principal story; otherwise the apertures will be disproportionate figures of themselves, and also to the whole facade in which they are placed.

The apertures of windows should not only be of shapely figures, and proportioned to the building, but the piers also should, in some measure, be regulated by the breadth of the apertures; at least, certain proportionable limits of this breadth ought to be assigned to that of the piers, so as not to offend the eye by their being too clumsy or too small, and at the same time permit a less or greater quantity of light, for a greater or less depth of rooms. As to the size of the piers, considerable latitude may be taken; but in general, they should not be of less breadth than the apertures, nor more than twice that breadth. In a small building, with only three rooms and three windows in the length, the piers will necessarily be large.

In buildings with a great number of windows in the length, where there are at least three windows in one or more principal rooms; and where there are no breaks, the breadth of the piers may be from once the breadth of the window, to once and a half that breadth; but if there are columns, pilasters, or breaks, the breadth of the pier may be from once to twice that of the apertures, according as the breadth of the pilasters or columns may require, so as to leave a proper repose of wall upon the sides.

The sills of windows should be from three feet to three feet six inches distant from the level of the floor, forming a parapet for leaning upon: these limits are the natural heights of the breasts of windows; but it

is now common, even in ordinary buildings, to make them from two feet to two feet six inches high only. In noblemen's houses, the sills are frequently upon the same level with the floor, and sometimes rise a step or two higher. These circumstances will alter the proportion of the windows, and make them much higher than the double square. The width of all the windows must be the same in the same façade; but the different heights of the stories will require different heights of windows. Were it required to find the quantity of light for a room of given dimensions, it is evident that this will depend upon the area of the inlet and the cubature of the room; therefore, supposing that an aperture containing 20 square feet is sufficient for a room 12 feet square and 10 feet high, that is, 1400 cubic feet, the quantity of light will easily be ascertained for a room of any other given dimensions. Let a room be supposed 25 feet long, 20 feet broad, and 14 feet high, the cubature will be 7000 feet; then, because the cubature of rooms should be as the area of the inlets, the proportion will stand thus:

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1440 : 7000 :: 20
                20
1440) 140000(97  the area of the in-
      12960        let required.
       10400
       10080
         320
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Or, instead of working the proposition, divide the cubature of the room by 72, thus:

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72) 7000 (97 as before.
    648
     520
     504
      16
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This quotient, divided into three parts, gives nearly 32 feet for each window, which is very sufficient for light; and after deducting 12 feet, the breadth of three windows, 13 feet will remain for the four piers, which is a very good proportion: there is also abundant room left for any kind of furnishing above the windows.

An odd number of windows, either in the same length of front, or in the same length of principal rooms, is always to be preferred to an even number; for, since it is necessary to have the door in the middle of the front, an even number of windows would occasion a pier to be above the opening of the door, contrary either to regularity or to the laws of solidity; and in rooms nothing is more gloomy than a pier opposite the centre of the floor. Windows placed in blank arcades should have the under sides of their lintels in the same horizontal plane with the springing of the arch; or if the windows have a cornice, the springing of the arch ought to be carried as high as the top of the cornice.

The aperture of the windows may be from two-fifths to three-fourths of the breadth of the arcade. In the principal floor, the windows are generally ornamented; the most simple kind of which is, that with an architrave, surrounding the jambs and lintels of the aperture, and crowned with a frize and cornice. In cases where the aperture is high, in order to make the dressing of a good composition, the sides of the architrave are frequently flanked with pilasters or consoles, or with both; and sometimes with columns, when there is a set-off or proper base, so as not to have a false bearing. When the principal rooms are in the one pair of stairs, the windows of the ground floor are sometimes left entirely plain, and at other times they are surrounded with an architrave; or the rusticated basement, where there is one, terminates upon their margins without any other finish. The windows in the third story are frequently plain, and sometimes surrounded with an architrave. When the windows in the principal story have pediments, the windows of the story immediately above have frequently their surrounding architraves crowned with a frize and cornice. The sills of all the windows in the same floor should be upon the same level. The sills of the windows in the ground story should be elevated five or six feet at the least above the pavement. In the exterior of every building, the same kind of finish or character should be preserved throughout the same story. Mixtures of windows should be avoided as much as possible; or where there is a necessity for introducing Venetian windows, they ought to stand by themselves, as in breaks.

Gates. A gate is an aperture in a wall, which serves for the passage of horsemen and carriages. They are employed as inlets to cities, fortresses, parks, gardens, palaces, and all places to which there is a frequent resort of carriages. In gates which

are closed at the top, the apertures being always wide, are generally made with arched heads: the usual proportion of the arcade is that which has its height double to its breadth, or a trifle more.

The usual ornaments of gates are rustics of several kinds, such as columns, pilasters, entablatures, pediments, attics, blocking courses, imposts, archivolts, consoles, masks, niches, &c. In gates which are not closed at the top, the breadth of the piers may be from two-fifths to a quarter of their height, reckoning from the bottom of the plinth to the top of the cornice.

The rustics may either be plain, frosted, or vermiculated. The smallest width that can be given to the aperture of a gate is nine feet, which is but just sufficient for the free passage of coaches; but if waggons and loaded carts are to pass, it must not be less than ten or eleven feet, and if the gate is for the entrance of a city, it should not be of a less width than eighteen or twenty feet. The composition of gates should be characteristic of the place to which they are to open. Gates of cities and fortresses should have the appearance of strength and majesty: their parts should be large, few in number, and of bold relief. The same ought likewise to be observed in the gates of parks, public walks, or gardens; these succeed better when composed of rustic work, and of the massive orders, than when they are enriched with nice ornaments or delicate profiles. However, triumphal arches, entrances to palaces, to magnificent villas, town or country houses, might with propriety be composed of the more delicate orders, and be adorned in the highest degree.

The gates of parks and gardens are commonly shut with iron folding grates, either plain or adorned: those of palaces should likewise be so, or else be left open all the day.

Niches. A niche is a recess in a wall, for the purpose of enshrining a statue or some other ornament, or as an ornament to the wall itself. Among the works of the Romans, niches have either that of a circular or rectangular plan: the heads of those which have circular plans are almost always spherical. In the middle of the attic of the piazza of Nerva, at Rome, there is a niche, with a rectangular elevation, and a cylindrical back and head: those upon elliptic plans were not much used by the ancients. In Wood's Ruins of Palmyra, there are, however, two exhibited with elliptic heads, within the entrance portico of the temple of the Sun; but no plan is shewn. Niches, upon rectangular plans, have most frequently horizontal heads: there are a few to be found with cylindrical heads: those upon circular and rectangular plans are, for the most part, placed alternately, for the sake of variety. The plans of niches with cylindrical backs should be semicircular, when the thickness of walls will admit of it; and the depth of those upon rectangular plans should be the half of their breadth, or as deep as may be necessary, for the statues they are to contain: their heights depend upon the character of the statues, or on the general forms of groups introduced; seldom exceeding twice and a half of their width, nor less than twice. Niches for busts should have nearly the same proportion with regard to one another; their heights, in some cases, may be something more than their breadth. Some niches may be formed with cylindrical backs and spherical heads: some of them may be entirely formed with hemispherical backs; others of spheroidal backs, with the transverse or conjugate axis of the ellipsis vertical, as may be most suitable to the character of the thing to be enshrined: those with spheroidal backs may have their horizontal sections all circles of different diameters, and, consequently, their sections through the vertical axes, all equal semi-ellipses, similar to each other; or all their horizontal sections may be similar ellipses, and the sections through the vertical axis of the niche will be dissimilar ellipses of equal heights, at least for one half of the niche; but spheroidal niches with such sections are difficult to execute, and not so agreeable to the eye as those with circular horizontal sections. Niches for busts may be of any of these last forms, or of any other form used by the ancients.

Niches are susceptible of the same decorations as windows; and whether their heads be horizontal, cylindrical, or spherical, the inclosure may be rectangular. In the ruined edifices of antiquity, tabernacles are a very frequent ornament, and these often disposed with triangular and arched pediments alternately: the character of the architecture should be the same as that which is to be placed in the same range with them. Niches are sometimes disposed between columns and pilasters, and sometimes ranged alternately in the same levels with windows: in either case they should be ornamented or plain, as the space will admit.

If the intervals between the columns or pilasters be very narrow, the niches will be much better omitted, than to make them either diminutive, or of a disproportionate figure. When they are ranged with windows, their dimensions should be the same as the aperture of the windows. Niches being intended as repositories for statues, vases, or other works of sculpture, must be contrived to set off the things they are to contain to the best advantage, and therefore no ornaments whatever should be introduced; the body and head of the niche being as plain as possible: every kind of ornament, whether mouldings or sculpture, tends to confuse the outline.

Statues. Besides decorations of mouldings, columns, and pilasters, architecture is indebted to sculpture for a great part of its magnificence; and as the human body is justly esteemed the most perfect original, it has been customary, in every period, to enrich different parts of buildings with representations thereof. Thus the ancients adorned their temples, basilicos, baths, theatres, and other public structures, with statues of their deities, philosophers, heroes, orators, and legislators; and the moderns still preserve the same custom, placing in their churches, palaces, houses, squares, gardens, and public walks, the busts and statues of illustrious personages; or bas reliefs and groups, composed of various figures, representing memorable occurrences, collected from the histories, fables, or traditions of particular times. Sometimes the statues or groups are detached, and raised on pedestals, and placed contiguous to the walls of buildings, by flights of steps or stairs, at the angles of terraces, in the middle of rooms, or of courts, and public squares, but most frequently they are placed in niches. The size of the statue depends upon the dimensions of the niche: it should neither be so large as to seem crammed into it, nor so small as to be lost in it. The distance between the outline of the statue and the sides of the niche, should never be less than one-third of a head, nor more than the half, whether the niche be square or arched; and when it is a square, the distance from the top of the head to the soffit of the niche should not exceed the distance left on the sides. The statues are generally raised on a plinth, the height of which may be from one-third to one-half of the head; and sometimes, where the niches are very large, in proportion to the architecture they accompany, as may be the case where an order comprehends but one story. The statues may be raised on small pedestals to a proper height, and by this means, the figure will not only have a better proportion to the niche, but also to the order, to which it would otherwise appear too trifling. Statues are not only placed in niches, but they are also placed on the tops of walls, and before the dwarf pilasters of attics, as in the arch of Constantine, and the Corinthian colonade at Thessalonica.

If there are two rows of niches in the same building, care must be taken to keep the statues of their proper attitudes. The character of the statue should always correspond to the architecture with which it is surrounded. Thus, if the order be Doric, Jupiter, Hercules, Pluto, Neptune, Mars, Esculapius, or any male figures, representing beings of a robust and grave nature, may be introduced. If Ionic, then Apollo, Bacchus, Ceres, Minerva, Mercury: and if Corinthian, Venus and the Graces, Flora, or others of a delicate kind and slender make, may very properly have place.

Proportions of rooms. The proportions of rooms depend much on their use and dimensions; but with regard to the beauty, all figures from the square to a sesquilateral, may be employed: some have even extended the length of the plan to double its breadth, but this disparity of dimensions renders it impossible to proportion the height to both length and breadth, though galleries are frequently three, four, or even five squares in length; but as the eye only takes in a portion of this length, the comparison is merely made in respect of the breadth. The height of rooms depends upon the dimension of their plans and the form of the ceilings. In rooms with flat ceilings, if their plan be a square, their height may be from two-thirds to five-sixths of the side; and if an oblong, it may be equal to the width. In coved rooms, if the plan be a square, the height may be equal to the side; if oblong, it may be equal to the breadth only: or with a fifth, a quarter, or a third of the difference of the length and breadth. In galleries, the height may be from one and a third, to one and three-fifths of the breadth. These are the general relative dimensions of rooms, but good proportions are not always attainable, particularly in houses of great magnitude: since the same common height is that of all the rooms, whatever be the difference of their

plans with regard to their size; however, to keep the best possible proportions, the principal rooms may have flat ceilings, and the middle-sized ones may be reduced by coving the ceilings with a flat in the middle; or by groins, or domes, as may answer their heights: but if the loftiest of these coved figures leaves still too great a height, recourse must be had to mezzanines; which are not only necessary for this purpose, but may always be employed with advantage, as they afford servants lodgings, baths, powdering-rooms, wardrobes, and other conveniences. All rooms of inferior classes may have mezzanines or intersoles.

In buildings where beauty and magnificence are preferred to economy, the halls, and galleries may be raised, making them occupy two stories. Saloons are frequently raised three stories, or the whole height of the building, and have galleries around their interior at the height of the floors, for communicating with the various parts of the building.

When rooms are adorned with an entire order, the entablature may occupy in height from one-sixth, to one-seventh of that of the room; if the entablature be without columns, it may have from one-seventh to one-eighth. If a cornice, frize, and astragal are executed, its height may be equal to a tenth; and if only a cornice, its height may be from a twentieth to a thirtieth part of that of the room. In general, all interior proportions and decorations must be less, and more delicate than those of the exterior. Architraves in most cases, should not be above one-seventh of the width.

Ceilings. The figures of ceilings are either flat or coved: coved ceilings either have a concavity around the margins, and are flat in the middle, or have a vaulted surface. (See VAULTS). Ceilings that are coved and flat, may occupy from one-fifth, to a fourth part of the height of the room: the principal sections of vaulted ceilings may be of various segments, equal to, or less than semicircles, as may be most suitable to the height of the room. Flat ceilings are adorned with large compartments, or foliages, and other ornaments, or with both. Compartment ceilings are either formed by raising mouldings on the surface, or by depressing the pannels within a moulded inclosure, which may be partly raised upon, and partly recessed within the framing, or entirely recessed: the figures of the pannels may either be polygonal, circular, or elliptical. The ceilings of the porticos and of the interior of ancient temples are comparted, and the pannels deeply recessed; the prominent parts between them representing the ancient manner of framing the beams of wood which composed the floors; the mouldings on the sides of the pannels are sunk, by one, two, or several degrees, like inverted steps, and the bottoms of pannels are most frequently decorated with roses; the figures of these compartments are mostly equilateral, and equiangular. Triangles were seldom used, but we find squares, hexagons, and octagons in great abundance. The framing around the pannels in Roman antiquity is constantly parallel, or of equal breadth, therefore when squares are introduced, there is no other variety; but hexagons will join in contiguity with one another, or form the interstices into lozenges, or equilateral triangles. Octagons naturally form two varieties, *viz.* that of their own figure, and squares in the interstices: this kind of compartment is called coffering, and the recessed parts coffers, which are used not only in plain ceilings, but also in cylindrical vaults. The borders of the coffering are generally terminated with belts, charged most frequently with foliage; and sometimes again the foliage is bordered with guillochis, as in the temple of Peace at Rome. In the ceiling of the entire temple at Balbec, coffers are disposed around the cylindrical vault, in one row rising over each intercolumn; and between every row of coffers is a projecting belt, ornamented with a guillochi, corresponding with two semi-attached columns in the same vertical plane, one column supporting each springing of the belt. The moderns also follow the same practice in their cupolas and cradle vaults, ornamenting them with coffers and belts: the belts are ornamented with frets guillochis, or foliages; small pannels are ornamented with roses, and large ones with foliage, or historical subjects, in a variety of different manners.

The grounds may be gilt and the ornaments white, partly coloured, or streaked with gold; or the ornaments may be gilt and the grounds white, pearl, straw-colour, light-blue, or any tint that may agree best with the ornaments. Some ceilings are painted either wholly, or in various compartments only: when a ceiling is painted in representation of a sky, it ought either to be upon a plane or spheric surface. A ceiling coved and flat, with the plane painted to represent the sky, is extremely

improper, as the cove represents the half of an arch upon every side of the room; it will seem as if falling, from the want of an apparent support in the middle, unless the ceiling rise from a circular plan. Ceilings coved and flat are much employed in modern apartments: they seem to be a kind of medium between the horizontal, and the various arched forms practised by the ancients: they do not require so much height as the latter, but they are neither so graceful nor so grand. Vaulted ceilings are more expensive than plane ones, but they are also susceptible of a greater variety of embellishments.

Chimnies. A chimney is an opening through a wall upwards, beginning at one side of a room, and ending at the top of a wall: its use is to warm the room, and give passage to the smoke. That part of the opening which faces the room is the place where the fire is put, and consequently is called the fire-place: the tube or hollow proceeding from the fire-place upwards, for giving vent to smoke, is called the funnel, or flue: the stone or marble laid level with the floor immediately before the fire-place is called the hearth or slab; and the one under the fire-place the back or inside hearth. The projecting parts of the walls on each side of the fire-place, forming also parts of the surface of the room, and standing at the extremities of the hearth, are called jambs: the head of the fire-place in the surface of a room, resting upon the jambs, is called the mantle: the mantle, and that part of the chimney resting upon it, forming a part of the side of the room, and also the whole side of the flue to the top, is called the breast; the side of the flue opposite to the breast is called the back; and the sides of the fire-place contained between the jambs and the back are called covings. When there are two or more chimnies in the same wall, the flues of which approach very near to each other, the thin division which separates one flue from another is either called a partition or a with; that part of the opening or horizontal section opposite to the mantle of a fire-place is called the throat; and that turret above the roof of a house, containing one or more flues, is called the shaft.

In stone walls the most common dimensions of the sections of flues are from 12 to 13 inches square, for fire-places about $3\frac{1}{2}$ feet wide in front; and those in brick walls 14 inches by 9 inches. The area of the section of the flue should always be proportioned to the area of the fire usually put in the fire-place, that is, nearly equal to the area of the horizontal section of the fire itself, excepting at the throat. The throat should be immediately over the fire, and its horizontal dimension in the thickness of the wall should not exceed $4\frac{1}{2}$, or 5 inches at most. The fuel grate, or stove, should be brought as near to the throat as conveniency may require. The coving should be placed bevelling nearer together at the back than at the jambs, making an exterior angle with the front of the jambs, and an interior angle with the back, of 135 degrees each. The back and covings forming the sides of the fire-place should be of white materials, such as white stone, or brick covered with plaster, which are most conveniently put up after the house is built. Most metals are unfavourable for this purpose. The top of the throat should be quite level, forming an abrupt plane. Some of the principles in the construction of chimnies are very well ascertained, others are not easily discovered till tried. The more the air that goes into the flue is rarefied, with the more force it will ascend, and the higher the flue the greater also will this force be; therefore the fire should have as little vacancy on either side as possible, and the flue, when convenient, should be carried as high as possible, and not have too wide an aperture at the top. The situation of doors in a room, the grate being placed too low, and other things, often occasion smoke; but whatever be the cause of it, if once discovered, the evil may easily be remedied. Circular flues are more favourable for venting than those whose sections are rectangular.

Vaults. A vault is an interior roof over an apartment, rising in a concave direction from the walls which support it, either meeting the vertex in a point or line, as when the section of the arch is Gothic; or one continued arch from the one abutment to the other, as when the section is a semicircle, or a segment less than a semicircle.

The vertical sections of the intradoes of vaults may be formed by an infinite variety of curves; but the most elegant forms are either circular or elliptic; which forms of sections have been generally adopted by the ancients of remote antiquity, by our ancestors throughout the middle ages, and by European nations at the present day. We shall therefore confine ourselves to those vaults which have their extradoes of circular and elliptic sections.

A cylindrical vault is a plain vault, the

figure of the extrados of which is a portion of a cylindric surface, terminating on the top of the walls which support it in a horizontal plane, parallel to the axis of the cylinder. This is also called a cradle vault.

A cylindroidal vault is a plain vault, the figure of the extrados of which springs from a horizontal plane; its section perpendicular to those lines is every where a semi-ellipsis, equal and similar throughout, and its base is that of either axis; or it is sometimes a segment of an ellipsis, less than a semi-ellipsis, having an ordinate parallel to the axis for its base.

A dome may be defined to be a vault rising from a circular, elliptical, or polygonal plan or base, such that all horizontal sections of the intrados are similar figures, having their centres in the same vertical line or axis, and such that the plans of any two sections may have the sides of similar inscribed figures parallel to each other, or that the figures of these plans may be concentric. If the dome is a portion of a sphere, that is, if its base be a circle, and its vertical section through the centre of its base the segment of a circle, then it is also called a cupola.

When the portion of a sphere, or cupola, springs from a wall on a polygonal plan, and the vertical axis of the sphere passes through the middle of the plan, then the spandrels, or triangular spheric portions, comprehended between the springing lines and a horizontal plane passing through the different summits of the walls, are called pendentives.

When two or more plain vaults penetrate or intersect each other, the figure of the intrados formed by the several branches is called a groin, or cross vault.

When two opposite equal branches meet other two opposite equal branches in two intersecting vertical planes, passing through the diagonal lines, joining the four exterior angles of the plane, the groin may be called an equal pitched quadrilateral groin.

If two opposite branches of an equal-pitched groin have cylindrical intradoes, and their plan of less breadth than that of the other two branches, the groin may be called cylindro-cylindroidal, or cylindroido-cylindric groin, according as the cylindric branches or the other two are of the greatest breadth.

When a groin consisting of four branches is made by two equal portions of cylindric surfaces, with the axis of the one cutting that of the other, it is called an equal-pitched cylindric groin.

When two opposite branches of a cylindric groin are of less breadth than the other two, it may be called un unequal-pitched cylindric groin. This is called by workmen a Welsh groin.

When the branches of a cylindric groin are of equal breadth in the plan, the groin may be called an equilateral cylindric groin.

It is not easy to give a geometrical definition that will extend to all properties of vaulting, called by writers of the first eminence, groins. The first given is almost universal. It applies not only to plain vaults intersecting each other, but also to those that are annular, or in the form of semi-cylindric rings, intersected by cylindric or cylindroidal plain vaults, the axis of which tends to that of the annulus. It does not, however, comprehend that species used in King Henry VII.'s chapel, Westminster, and King's College chapel, Cambridge.

This species of groins, instead of the horizontal sections of the curved surfaces presenting exterior right angles, as is generally the case, present convex arches of circles. There is yet one property that is common to every species of groins, that is, the several branches intersect and form arches upon each inclosing wall, and the perpendicular surface of the wall upon each side is continued till it is intercepted by the entrados of the arches; consequently the upright of each wall is equal in height to the summit of the arches. Hence the difference between groins and domes. A groin is a branched vault, and each branch terminates against the enclosing walls; whereas a dome is a vault without branches, and the curves spring from the wall, or walls, from all points around its bottom circumference, whether the walls stand upon a polygonal, circular, or elliptic plan.

The Greeks, it would appear, had few or no arches or vaults much prior to the reign of Augustus, from which time they sometimes employed plain vaults with cylindrical intradoes; we also find that they used quadrilateral, equal-pitched groined vaults, with cylindrical or cylindroidal intradoes, or mixed of both, over the passages of the theatres and gymnasia.

The Romans, as would appear also, did not employ vaults more early than the Greeks. The Pantheon, one of the earliest remaining structures with arches, was probably built by Agrippa, the son-in-law of

Augustus, though some maintain that he only added the portico; but of this there is no proof, as no mention is made of this celebrated building before his time. We find from Vitruvius (lib. iii. c. 3,) that the floors of temples were frequently supported by vaults, and (lib. v. c. 1.) that the roofs of basilicas were vaulted of the tortoise form, which he distinguishes by the name of testudo. This form of vaulting is very flat, with four curved sides springing from each of the four walls, and it approaches nearly to that of a flat dome upon a rectangular plan.

We also find, from the remains of Roman buildings, the ceiling of their apartments vaulted. The side apartments, or chapels, of the Temple of Peace, and of the baths of Dioclesian, have vaults with cylindrical intradoes, while the great rectangular apartment in each of these edifices is vaulted in the groined form; and it is remarkable that the groins are not formed by the intradoes of the vaults in the chapels, for the summits of the vaults in these rises but a small distance above the springing of the middle groins. It may also be remarked, that the piers between the chapels have small arcades, the summits of which are considerably below the cylindrical intradoes of the side vaults. This circumstance is not peculiar to these buildings, as is to be found in many others. This is to be seen distinctly in the plates of the temple of Peace, by Desgodetz. The Romans employed annular vaults, as in the temple of Bacchus; and in this, as in the temple of Peace, and the baths of Dioclesian, the summits of the arcades supporting the cylindric wall and dome of the central apartment do not intersect the annular intrados; but the convex side of the cylindric wall which supports this annular intrados, and consequently do not form groins. The intradoes of the Roman domes are of a semicircular section, as may be seen in the Pantheon, the temple of Bacchus at Rome, the temple of Jupiter, and vestibule of the palace of Diolesian, at Spalatro, in Dalmatia, while the vertical section of the extradoes through the axis is a much less segment, as the Pantheon at Rome, and the vestibule and palace of Dioclesian exhibit. We have no instances among the Roman or Grecian buildings of pendentives or spandrels which are supported by four pillars, or by quadrangular or polygonal walls, and which support themselves on a spheric dome or cylindrical wall. Pendentives rising from four pillars, and a dome from the top of the pendentives, were first put in practice, it is said, in the celebrated church of Sancta Sophia at Constantinople.

In the rectangular buildings of the middle ages quadrangular, equal-pitched groins were generally used; and in circular buildings we have annular groins, as in the Church of the Holy Sepulchre at Cambridge, and Temple Church, London. We have also mentioned those curious groins which are exhibited in the ceilings of King's College Chapel, Cambridge; St. George's Chapel, Windsor; and King Henry the Seventh's Chapel, Westminster, of modern invention.

In the present day every species of vaulting, that were either used by the ancients or throughout the middle ages, are employed, both for the sake of variety and for elegance.

It does not appear that the ancients were acquainted with cylindrical, unequal-pitched groins, at least by way of ornament; this form is however very beautiful, as the arcades above the passage through the front of Somerset-House clearly exhibit.

ARCHYTAS, of Tarentum, in biography, a celebrated mathematician, cosmographer, and Pythagorean philosopher, of whom Horace says

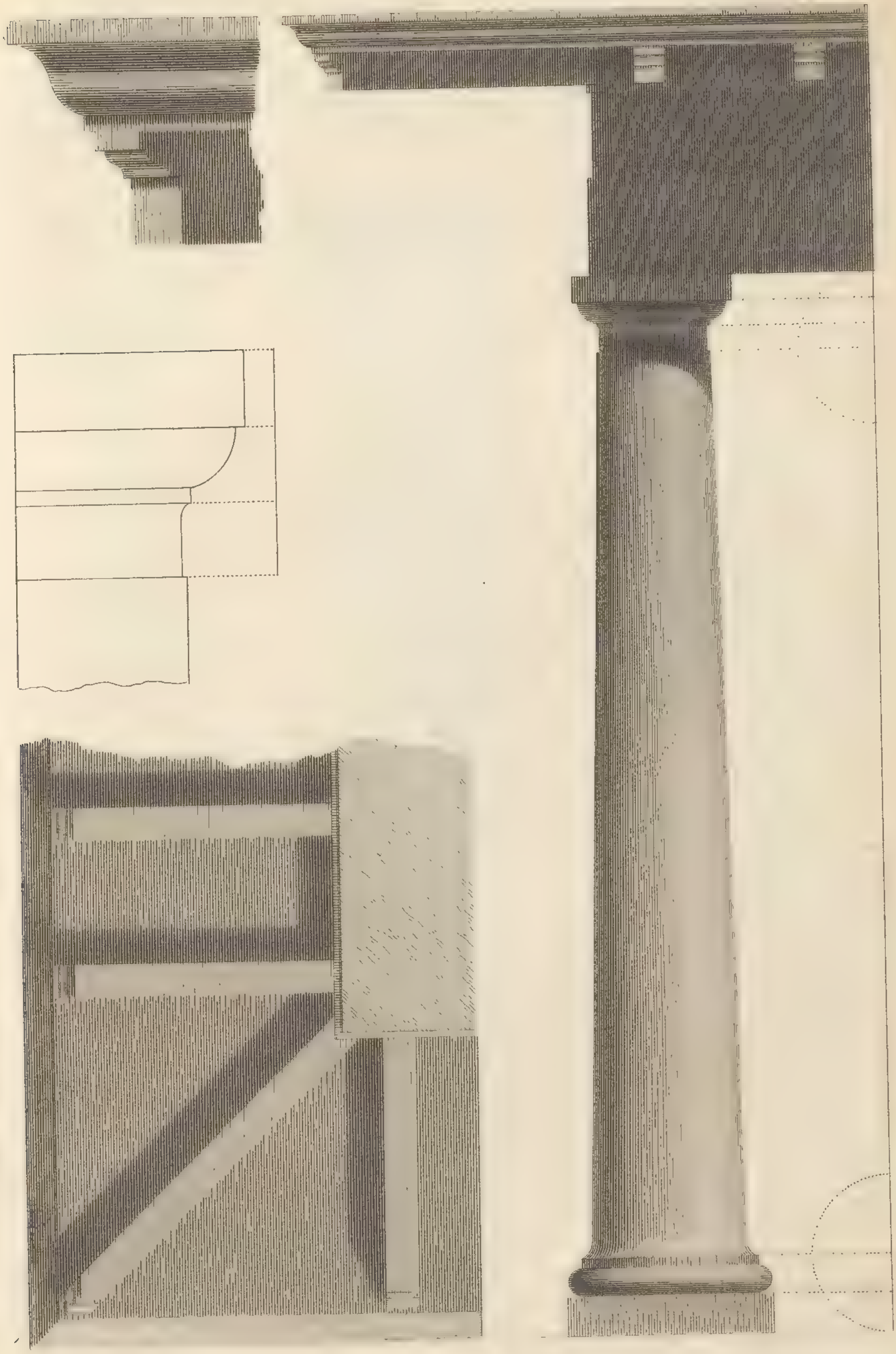
——Maris ac terræ, numeroque carentis arenæ
Mensorem cohibent, Archyta, &c.

He flourished about 400 years before Christ, and was the master of Plato, Eudoxus, and Philolaus. He gave a method of finding two mean proportionals between two given lines, and thence the duplication of the cube, by means of the conic sections. His skill in mechanics was such, that he was said to be the inventor of the crane and the screw; and he made a wooden pigeon that could fly about, when it was once set off; but it could not rise again of itself, after it rested. He wrote several works, though none of them are now extant, particularly a treatise Περι τȣ Παντος, *De Universo*, cited by Simplicius in Arist. Categ. It is said he invented the ten categories. He acquired great reputation both in his legislative and military capacity; having commanded an army seven times without ever being defeated. He was at last shipwrecked, and drowned in the Adriatic sea.

Archytas was distinguished through life by modesty and self-command. He maintained that virtue was to be pursued for its own sake, in every condition of life; that

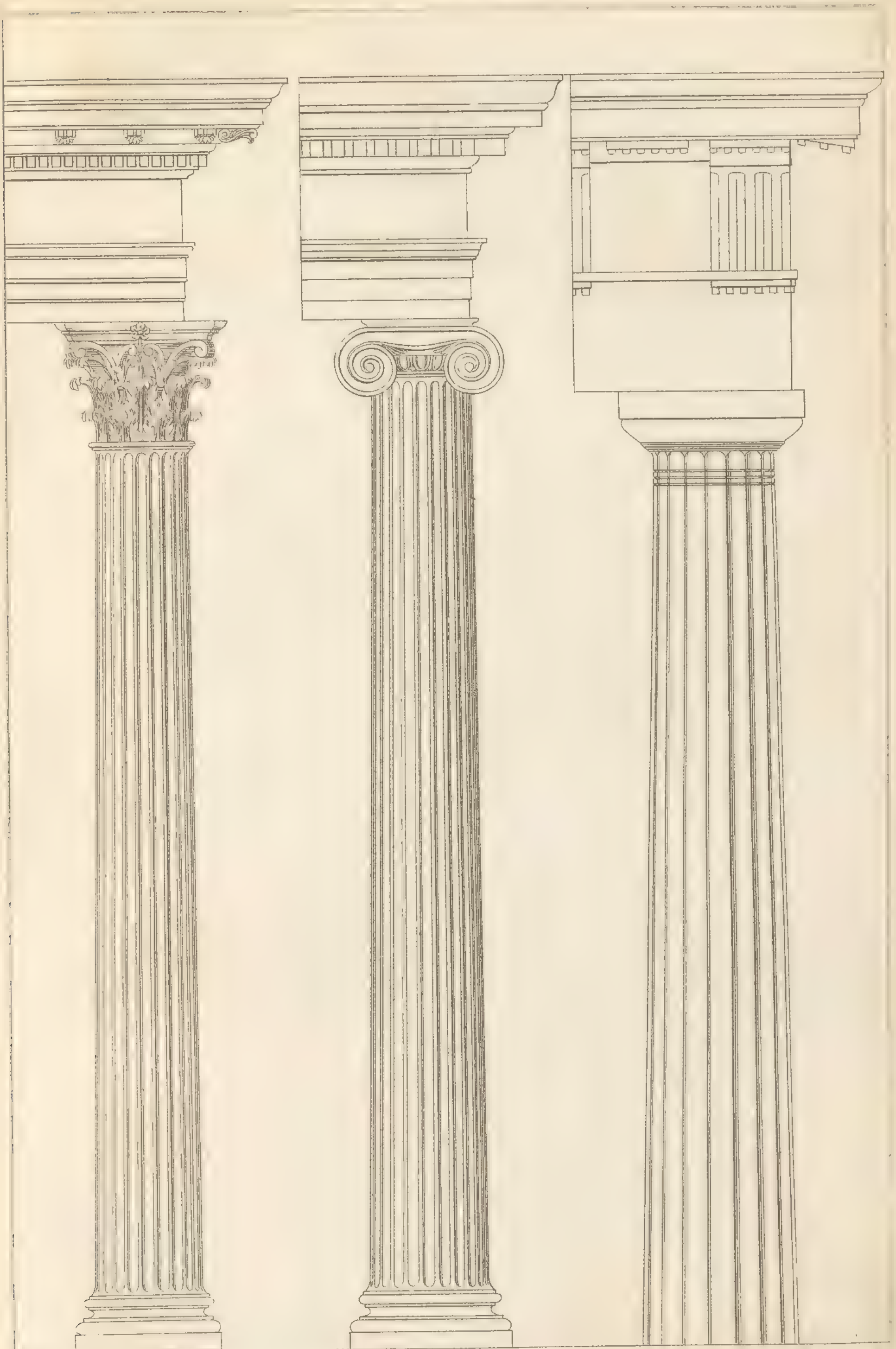
ARCHITECTURE.

Tuscan Order.



Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, June 1st 1808.



J. Farey Jun. delin. Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, 1809.

all excess is inconsistent with virtue; that the mind is more injured by prosperity than by adversity; that there is no pestilence so pernicious to human happiness as pleasure; and that the love of it is a disease destructive to the human mind.

ARCTIC, in astronomy, an epithet given to the north pole, and likewise to a circle of the sphere parallel to the equator, and 23 degrees 30 minutes distant from the north pole.

ARCTIUM, the *burdock*, in botany, a genus of the Syngenesia Polygamia Æqualis class of plants; the common calyx of which is globose and imbricated; the compound flower is tubulated and uniform, with equal hermaphrodite corollulæ: the proper flower is monopetalous and tubulous, with a slender and very long tube; there is no pericarpium; the cup is connivent, and the seed single, vertically pyramidical, and crowned with a simple down shorter than the seed. There are two species; *viz.* the Laffa and Bardana.

ARCTOMYS, the *marmot*, in natural history, a genus of the Mammalia class of animals, of which the generic character is, front teeth two in each jaw, strong, sharp, and cuneated; grinders in the upper jaw, five on each side, in the lower jaw four; clavicles or collar bones perfect. This genus differs but little from the Mus tribe, so that naturalists have sometimes doubted whether they should be separated into distinct genera. They are diurnal animals; feed on roots, grain, and fruits, which they often collect in heaps. They reside in subterraneous holes, and become torpid in the winter. The head is gibbous, or rounded, with short ears, or none; body thick; tail short; hairy; fore feet four-toed, with a very short thumb; hind feet five-toed; cœcum large. There are eleven species, of which we shall notice the following: 1. Arctomys marmota, or Alpine marmot: ears short, round; body brown, beneath reddish. It inhabits dry open places, on the summits of the Alps and Pyrenees; feeds naturally on roots, herbs, and insects; when tamed it will eat any thing that is offered; drinks little; basks in the sun; lives among small tribes, with a centinel placed to give notice of danger, which is done with a hiss; forms a burrow with many chambers and entrances, for the summer; another lined with soft grass, in which it remains torpid during winter; it eats with its fore paws; walks on its heels, often erect; is easily caught when out of his burrow; in a tame state very destructive of food, cloaths, and furniture; hardly kept awake in winter, even in warm chambers; gravid seven weeks, and brings from two to four at a time. These animals make no provision for the winter, but as soon as the frosts set in, they carefully stop up the entrances to their mansions, and gradually fall into a state of torpidity, in which they continue till the beginning of spring, when they awake and commence their excursions. Before they retire to winter quarters they grow excessively fat, and appear very emaciated on first emerging from them. If carefully dug up during the winter, they may be conveyed away in their sleeping state, and when brought into a warm chamber gradually awaken.

The Quebec marmot is rather larger than a rabbit, with short ears and a round head. It inhabits Hudson's Bay and Canada. A. monax, or Maryland marmot is found in various parts of North America, and in its habits and manners is very like that already noticed. The marmot, when taken young, may be easily domesticated, and taught to perform various gesticulations, such as holding a stick, dancing, &c. See Plate II. Mammalia, in which will be seen the hamster and lemming, sometimes called the Lapland marmot: descriptions of these will be found in the article MUS. A. bobac, or grey marmot is a native of the high, but milder and sunny sides of mountainous countries, which abound with free-stone rocks, where it is found in dry situations. It frequents Poland and Russia, among the Carpathian hills: it swarms in the Ukraine, about the Boristhenes, and between this river and the Don, and along the range of hills which extend to the Wolga. It is found about the Yaik, and inhabits the southern desert in Great Tartary. It is not to be seen in Siberia, on account of its northern situation, and rarely reaches in Kamschatka as high as 55°. The colour is grey above, with the throat, inside of the limbs, and under parts of the body fulvous or ferruginous; the tail is short, rather slender, and full of hair. Its manner of life resembles the Alpine marmot. The holes of these animals are lined with the finest hay, and in such quantities that, it is said, enough has been found in a single receptacle to feed a horse for a night. A. citillus, or variegated marmot, is the most beautiful of all the species; in size it differs very much; some are as large as the Alpine marmot, and others not larger than a common water rat. The variegated marmot inhabits Bohemia and

other parts of Germany, from the banks of the Wolga to India aud Persia, through Siberia and Great Tartary to Kamschatka, and even the continent of America. It is not certain that these sleep in the winter like others of the Arctomys genus. They breed in the spring, and produce from five to eight at a time. They are said to be irascible and quarrelsome among themselves, and their bite is very severe. They feed not only on animal food, but on small birds and other animals, which they will kill. They are easily tamed, and will grow familiar in a few days. They are extremely clean, and after feeding, generally wash their faces, and clean their fur. Like other domestic animals, they are fond of being caressed, and will feed from the hand. Their sleep is profound during the whole night, and in cold and rainy weather through the greater part of the day. See Plate II. Mammalia, fig. 1, 2, and 5.

ARCTOPUS, in botany, a genus of the Polygamia Dioecia class of plants, the general umbel of which is long nnd unequal; the partial umbel is shorter; the involucra consist of five leaves; the corolla of five petals; the fruit is single and bilocular, and stands under the receptacle of the floscule; the seed is single, cordated, and acuminated. There is but one species.

ARCTOTHECA, in botany, a genus of the Syngenesia Necessaria: receptacle cellular and chaffy; calyx imbricate. There is but one species.

ARCTOTIS, in botany, a genus of the Syngenesia Necessaria class of plants, the common calyx of which is roundish and imbricated; the compound flower is radiated; the hermaphrodite corollulæ are tubulous and numerous in the disk: the proper hermaphrodite flowers are funnel-shaped; there is no pericarpium; the seed is single, roundish, and hairy. This genus is separated into the following divisions: A. receptacle villous, 31 species; B. receptacle chaffy, 11 species; C. doubtful, 18 species.

ARCTURUS, a fixed star of the first magnitude, in the skirt of Boötes: so called from the circumstance of its being near the tail of the Bear. It has been thought to be the nearest fixed star to our system visible in the northern hemisphere, because the variation of its place, in consequence of a proper motion of its own, is more remarkable than that of any other of the stars, and by comparing a variety of observations respecting the quantity and direction of the motion of this star, he infers, that the obliquity of the ecliptic decreases at the rate of 58″ in 100 years, a quantity that nearly corresponds to the mean of the computations framed by the celebrated Euler and Lalande, upon the more unerring principles of attraction.

ARCTUS, in astronomy, the Greek name for the Ursa Major and Minor.

ARDEA, in natural history, a genus of birds of the order Grallæ. The characters of this genus are, a long, strong, sharp-pointed bill; nostrils linear; tongue pointed; toes connected by a membrane as far as the first joint; the middle claw of some of the species, of which there are 79, pectinated. This genus is separated into five divisions, *viz.* A. crested; bill hardly longer than the head; B. cranes, bald; C. storks, orbits naked; D. herons, middle claw serrate inwardly; E. bill gaping in the middle.

Some ornithologists have separated the herons from the storks and cranes; others preferring the Linnæan system, class the whole under one genus, which according to Gmelin, consistis of nearly 100 species, though Latham enumerated but 79. They are widely distributed over various parts of the globe, differing in size, figure, and plumage, and with talents adapted to their various places of residence, or their peculiar pursuits. But notwithstanding the variety in their bills and plumage, the manners of all are nearly the same, so also is their character which is stigmatized with cowardice and rapacity, indolence and yet insatiable hunger; and it has been observed that from the meagre-looking form of their bodies one would suppose the greatest abundance almost insufficient for their support.

Ardea pavonia. This is as large as the common heron; the length two feet nine inches; the bill is two inches and a half long, straight, and of a brownish colour; irides grey; the crown of the head covered with soft black feathers like velvet; on the hind part is a tuft composed of hair, or rather bristles, arising near each other at the base, and spreading out on all sides in a globular form; this is four inches in length, and of a reddish brown colour; the sides of the head are bare of feathers, being covered only by a fleshy membrane, of a reddish colour at the lower part, and in shape not unlike a kidney; on each side of the throat hangs a kind of wattle; the general colour of the bird bluish-ash; the feathers on the fore part of the neck are very long, and hang over the breast; wing coverts white; the greater ones incline to rufous, and those

AVES

AVES.

Fig.1. **Anas** *cygnus mansuetus: Mute Swan. Fig. 2. A. erythropterus: Bernacle duck. Fig. 3. A. mollissima: Eider duck. Fig. 4. A. marila scaup duck. Fig. 5. A. clangula: golden eye. Fig. 6.* Aptenodytes *patachonica: Patagonian Penguin. Fig. 7.* Ardea *stellaris: bittern.*

farthest from the body to black; the greater quills and tail are black, and the secondaries chesnut; the legs and the bare part above the knee are dusky. The female is black where the male is blue-ash; and the wattles on the throat are wanting; the long feathers on the breast are also less conspicuous. This beautiful species is an inhabitant of Africa, particularly the coast of Guinea, as far as Cape Verd; at this last place they are said to be wonderfully tame, and will often come into the court-yards to feed with the poultry. Why the name of Balearic crane has been given to this bird is not well ascertained, as it is certainly not met with in the Balearic Islands at this day. These birds are often kept in our menageries, and with shelter at night often live a good while. Their chief food is supposed to be worms, and such other things as the heron tribe usually feed on; also vegetables of all kinds. It often sleeps on one leg, runs very fast, and is said not only to fly well, but to sustain it for a long time together. The flesh of this bird is said to be very tough.

Ardea virgo, or the Numidian crane. Size of the crane: length three feet three inches; the bill straight, two inches and a half long, greenish at the base, then yellowish, with the tip red; irides crimson. The crown of the head is ash-colour; the rest of the head, the upper part of the neck behind, and all the under parts to the breast, black; on the last the feathers are long and hang downwards; the back, rump, and tail, and all the under part from the breast, are of a bluish ash-colour; behind each eye springs a tuft of long white feathers which decline downwards, and hang in an elegant manner; the quills and tail are black at the ends; the legs are black. This species is found in many parts of Africa and Asia. In the first it has been met with on the coast of Guinea; but is most plentiful about Bildulgerid (the ancient Numidia), and Tripoli; from thence along the coasts of the Mediterranean Sea, and pretty common in Egypt. They are also at Aleppo, and in the southern plain about the Black and Caspian Seas; and are seen frequently beyond Lake Baikal, about the rivers Selenga and Argun, but never venture to the northward. In all places they prefer marshes and the neighbourhood of rivers, as their food is fish, like most of the heron genus. It is frequently kept in menageries, being endowed with great gentleness of manners, added to its being an elegant bird. At various times it puts itself into strange and uncouth attitudes, and especially those which imitate dancing: and Keysler mentions one in the Great Duke's Gallery at Florence, which had been taught to dance to a certain tune when played or sung to it. The name this bird is known by in the east is Kurki, or Querky. See Plate II. Aves, fig. 7.

Ardea grus. This is a large bird, not unfrequently weighing ten pounds, and measures more than five feet in length. This species seems far spread, being met with in great flocks throughout northern Europe and Asia, in Sweden, Russia throughout, and Siberia as far as the river Anadyr, migrating even to the Arctic Circle. In Kamtschatka only seen on the southern promontory; are migratory, returning northward to breed in the spring, and generally choosing the same places which had been occupied by them the season before. In the winter they inhabit the warmer regions, such as Egypt, Aleppo, India, &c. they are also met with at the Cape of Good Hope, changing place with the season. In their migrations frequently fly so high as not to be visible; their passing only being known by the noise they make, being louder than that of any other bird. In France they are seen spring and autumn; but for the most part are mere passengers. We are told that they frequented the marshes of Lincolnshire and Cambridgeshire, in vast flocks, formerly; but the case is altered, as of late none have been met with, except, a few years since, a single bird shot near Cambridge. We are told that they make the nest in the marshes, and lay two bluish eggs. The young birds are thought very good food. They feed on reptiles of all kinds, and in turn on green corn; of which last they are said to make so great havock as to ruin the farmers wherever the flocks of these depredators alight.

Ardea ciconia, or white stork, is the size of a turkey, inhabits in turns the various parts of the old continent, avoiding alike the extremes of heat and cold, being never met with between the tropics, nor scarcely ever seen more north than Sweden, or in Russia beyond 50°. It never frequents Siberia, though it is sometimes found in Bucharia where it makes its nest, tending towards the south in autumn to winter in Egypt. It is rarely met with in England, though well known in France and Holland. They every where build on the tops of houses, and the good natured inhabitants provide boxes for them to make their nests in; they not only do this, but are particularly careful that the birds suffer no injury,

resenting it as done to themselves. At Bagdad they are to be seen on every house, wall, and tree, quite tame. At Persepolis the remains of the pillars serve them to build on, every pillar having a nest. They are thought to have two broods in a year, the first towards the north, the latter in warmer places; and are seen in vast flocks during their migrations. The female makes a large nest and lays from two to four eggs. The young are hatched in a month; the male and female watch them by turns till they can provide for themselves. The stork sleeps on one leg, and snaps with its bill in a singular manner. Its food consists in snakes and other reptiles; hence the veneration of all persons for this bird which frees them from such pests.

Ardea stellaris, or bittern. This is an elegant species, and is somewhat less than the heron; length two feet six inches; the bill brown, beneath inclining to green; irides yellow; the head feathers are long, and those of the neck loose and waving; the crown of the head black; the lower jaw on each side dusky; the plumage in general is beautifully variegated; the ground a ferruginous yellow, palest beneath, marked with numerous bars, streaks, and zigzag lines of black; the legs are pale green; claws long and slender; and the inner edge on the middle claw serrated. The female is less, darker coloured, and the feathers on the head and neck less flowing than in the male. This is a common bird in our islands, and we believe in most of the temperate parts of the continent; in some of the colder, migratory; with us it remains the whole year; frequents marshy places, and especially where reeds grow, among which it makes the nest, in April, which is chiefly composed of a bed of rushes, &c. The female lays four or five eggs of a pale greenish ash colour; the young are hatched in twenty-five days. It is an indolent bird, stirring very little in the day unless disturbed; though if once roused is not difficult to shoot, as it flies heavily. In the evening, after sun-set, it is seen to soar aloft in a spiral ascent, till quite out of sight, and this chiefly in autumn, making a singular kind of noise; it has also another noise, like that of a bellowing bull, beginning in February and ceasing after breeding-time; but this is done while on the ground. If attacked by dogs or men, it defends itself well; and is said to strike at the eyes of the enemy. The food is frogs, mice, and other reptiles, which it swallows whole, as well as fish. Latham remembers to have found two middle-sized trouts in the stomach of one perfectly whole. It is reckoned pretty good eating. See Plate III. Aves, fig. 7. and Plate IV. fig. 1.

ARDISIA, in botany, a genus of the Pentandria Menogynia class and order. Calyx five-leaved; corol salver-shaped, with the border reflected; antheræ large, erect; stigma simple; drupe superior; one-seeded. There are nine species.

ARDUINA, in botany, a genus of the Pentandria Monogynia class and order. Corol one-petalled; stigma bifid; berry two-celled; seeds solitary; a shrub of the Cape of Good Hope.

ARE, in French measure, is a superficial unit, or a square, the side of which is 100 metres in length, or 10,000 square metres; the rectilineal metre being 3.281 feet, the are will be 1076.49 square feet. The tenth of an are, called deciare, is a superficies 100 metres long, and 10 broad; or 1000 square metres = 1076.49; and the centiare equal to 100 square metres, is 1076.49 square feet. See MEASURE.

AREA, in geometry, denotes the superficial content of any figure; thus, if we suppose a parallelogram six inches long, and four broad, its area will be $6 \times 4 = 24$ square inches.

ARECA, in botany, a genus of plants, the characters of which are not perfectly ascertained; the calyx of the male flower is a bivalve spatha, the spadix is ramose; the corolla consists of three acuminated petals; the stamina are nine filaments, of which the three exterior ones are the longest; the female flowers are in the same spadix and spatha; the corolla is like the male corolla; the fruit is a sub-oval fibrose drupe, surrounded at the base with an imbricated calyx, and containing an oval seed.

There are three species, of which the oryzæformis is the cabbage-tree of the East Indies. The oleracea is found in the West Indies, the green tops of which are cut and eaten as a cabbage.

ARENARIA, *sand-wort*, in botany, a genus of the Decandria Trigynia. Calyx five-leaved, spreading; petals five, entire; capsule superior, one-celled, many-seeded. There are 36 species.

ARENARIUS, the name of a book of Archimedes, in which is demonstrated, that not only the sands of the earth, but even a greater quantity of particles than could be obtained in the immense sphere of the fixed stars, might be expressed by numbers, in a way invented and described by himself.

AREOMETER, an instrument by which

the density and gravity of fluids are measured. The invention of this instrument is ascribed to Hypatia, the daughter of Theo, in the fourth century. It is usually made of glass, consisting of a round hollow ball, which terminates in a long slender neck, hermetically sealed at top, there being first as much running mercury put into it, as will serve to balance, or keep it in an erect position. The neck or stem is divided into degrees, and by the depth of its descent into any liquor the lightness of that liquor is estimated, for the fluid in which it sinks least is the heaviest; and that in which it sinks lowest is lightest. See HYDROMETER.

AREOPAGUS, in antiquity, a sovereign tribunal at Athens, famous for the justice and impartiality of its decrees; to which the gods themselves are said to have submitted their quarrels. This tribunal was in great reputation among the Greeks, so that it was denominated "the most sacred and venerable tribunal," and Socrates says that it was deemed so sacred, that if those who had been vicious were elected into it, they immediately gave up their former practices, and conformed to the rules of the senate, because they could not resist the authority of example, but were constrained to appear virtuous. The Romans themselves had so high an opinion of it, that they trusted many of their difficult causes to its decision. Demosthenes says, that in his time neither plaintiff nor defendant had any just reason to be dissatisfied with their proceedings. Innocence, summoned to appear before it, approached without apprehension; and the guilty, convicted and condemned, retired without daring to murmur. Authors are not agreed about the number of the judges who composed this august court. Some reckon thirty-one, others fifty-one, and others five hundred; in reality their number seems not to have been fixed, but to have been more or less in different years. By an inscription quoted by Volaterranus, it appears they were then three hundred. At first this tribunal only consisted of nine persons, who had all discharged the office of archons, had acquitted themselves with honour in that trust, and had likewise given an account of their administration before the logistæ, and undergone a very rigorous examination. Those who were admitted members of this assembly, were strictly watched, and their conduct was scrutinized and judged by the court to which they belonged, without partiality. Trivial faults did not escape censure. A senator, it is said, was punished for having stifled a little bird, which from fear had taken refuge in his bosom; he was thus taught, that he who has a heart shut against pity, should not be allowed to have the lives of the citizens at his mercy. The members of this august assembly were not allowed to wear crowns, or to obtain any marks of honour conferred by the people, as a recompence for their services; nor were they allowed to solicit any; but they were rewarded by a bounty from the public, and they had also three oboli for every cause in which judgment was given. The areopagites were judges for life. They never sat in judgment but in the open air, and that in the night time; to the intent that their minds might be more present and attentive; and that no object, either of pity or aversion, might make any impression upon them. However, some maintain, that the building in which the areopagites assembled was not wholly uncovered; and they observe, that among the ruins, large stones have been found, whose joints are in the same angle with the pediment that must have been used for a covering. Mr. Spon, who examined the antiquities of that illustrious city, found some remains of the areopagus still existing in the middle of the temple of Theseus, which was heretofore in the middle of the city, but is now without the walls. The foundation of the areopagus is a semicircle, with an esplanade of 140 paces round it, which properly made the hall of the areopagus. There is a tribunal cut in the middle of a rock, with seats on each side of it, where the areopagites sat, exposed to the open air. At first they only took cognizance of criminal causes; but in course of time their jurisdiction became of greater extent. This court is recorded as the first that sat upon life and death; and the trial of wilful murder seems to have been the original design of its institution. In later ages, all incendiaries, assassins, conspirators, deserters of their country, treasons, and most capital causes in general, fell under its cognizance. The opinion which the state entertained of the wisdom, gravity, and sanctity of its members, gained for them an unlimited power; insomuch that, according to Solon's regulation of this assembly, the inspection and custody of the laws, the management of the public funds, the guardianship of young men, and the education of youth, according to their rank, were committed to them. Their power extended to persons of all ages and sexes, to punish the idle and profli-

gate, and to reward the sober and virtuous, according to their own pleasure. For this purpose, they were empowered, by entering and examining private houses, to condemn every useless person as dangerous: and every expense not proportioned to the means of the citizen as criminal. Besides, they took cognizance of religious matters, blasphemy, contempt of holy mysteries, the erection and consecration of temples and altars, and the introduction of new ceremonies: nevertheless, they interfered in public affairs only in cases of emergency or danger. As this assembly exhibited the greatest firmness in punishing crimes, and the nicest circumspection in reforming manners; as it never employed chastisement till advice and menaces were slighted, it acquired the esteem and confidence of the people, even whilst it exercised the most absolute power. Its meetings were held three times in every month, *viz.* on the 27th, 28th, and 29th days, but on any urgent business, the senators assembled in the royal portico. The court was divided into several committees, each of which took cognizance of separate causes, if the multiplicity of business would not allow time for them to be brought before the whole senate: and this was done by lots, that the causes might not be prejudged. In crimes that concerned religion or the state, the power of this court was limited to preparing the matter for a trial; and it then made its report to the people, without coming to any conclusion. The accused then had it in his power to offer new pleas in his defence; and the people named orators to conduct the prosecution before one of the superior courts. Trials in the areopagus were preceded by tremendous ceremonies. The two parties, placed amidst the bleeding members of the victims, took an oath, which they confirmed by dreadful imprecations against themselves and families. They called to witness the Eumenides, who, from a neighbouring temple, dedicated to their worship, seemed to listen to the invocation, and prepare to punish the perjured. They then proceeded to the trial, requiring all pleadings to be conducted in the simplest terms, without exordium, epilogue, or appeal to the passions. After the question had been sufficiently discussed, the judges silently deposited their suffrages in two urns, one of brass, called the urn of death; and the other of wood, called the urn of mercy. This mode of giving votes was afterwards abandoned, and they were delivered in public, by casting their calculi or flints upon two tables, one for those that were acquitted, and the other for those condemned: when the numbers were equal, an inferior officer added, in favour of the accused, the suffrage of Minerva, so called, because, according to an ancient tradition, this goddess being present in the court of areopagus at the trial of Orestes, gave her casting vote to turn the scale of justice. In some causes the sentence of this court was not final; but an appeal might be made to the courts to which they respectively belonged.

ARETHUSA, in botany, a genus of the Gynandria Decandria class of plants, having no other calyx than a foliacious spatha; the corolla is ringent, and consists of five oblong sub-equal petals; the nectarium consists of a single leaf, divided into two segments; the fruit is an oblong oval capsule, consisting of three valves, and containing one cell, in which are several seeds. There are seven species.

ARETIA, in botany, a genus of the Pentandria Monogynia class of plants, the calyx of which is a perianthium, consisting of a single campanulated, semiquinquefid, and permanent leaf, without any involucrum; the corolla consists of a single petal; the tube is oval, and of the length of the cup; the limb is divided into four segments; and the fruit is a capsule, in which are contained many seeds. There are four species.

ARGEMONE, in botany, a genus of the Polyandria Monogynia class of plants, the calyx of which is a roundish spatha, composed of three hollow, pointed, deciduous leaves; the corolla consists of three roundish, erecto-patent petals, larger than the cup; the fruit is an oval pentangular capsule, containing one cell, and seeming as if formed of five valves; the seeds are numerous and very small; the receptacles are linear, and grow to the angles of the pericarpium: they do not burst. There are three species.

ARGENT, in heraldry, the white colour in the coats of gentlemen, knights, and baronets: the white in the arms of sovereign princes is called luna, and that in the arms of the nobility pearl; this is expressed in engraving by the parts being left plain, without any strokes from the graver.

ARGENTINA, in natural history, a genus of fishes, of the order Abdominales: teeth in the jaws and tongue; gill membrane, with eight rays; vent near the tail; ventral fins many rayed. There are four

species. A. sphyræna, or European atherine, inhabits the Mediterranean, and sometimes wanders to the British coast, it is from two to four inches long; body round and tapering; back and sides, as far as the lateral line, pale ash mixed with green, below the line and belly fine silvery; the air-bladder is conic on both sides, appearing as if covered with silver leaf, and is used in the manufacture of artificial pearls. A. glossodonta, is a very elegant species found in the Red Sea: as is also A. machnata; but the other species, A. carolina, which is the size of a small herring, is found in the fresh waters of Carolina.

ARGENTUM *vivum*. See MERCURY.

ARGIL. See ALUMINA.

ARGONAUTA, in natural history, a genus of worms, of the order Testacea. Animal a sepia or clio; shell univalve, spiral, involute membranaceous, one-celled. There are five species. A. argo has the keel, or ridge of the shell slightly toothed on each side; it inhabits the Mediterranean and Indian oceans, and is the famous nautilus, supposed in the early ages of society to have first taught men the use of sails. When it means to sail it discharges a quantity of water, by which it is made lighter than the sea, and rising to the surface, erects its arms and throws out a membrane between them, by which means it is driven forwards like a vessel under sail: two of the arms it hangs over the shell, to serve as oars or a rudder. The shell is white or yellowish, with smooth or knotty striæ or ribs, which are sometimes forked; the keel is generally brownish.

ARGOPHYLLUM, in botany, a genus of the Pentandria Monogynia class and order. Calyx five-cleft, superior; corol five-petalled; nectary pyramidal, five-angled, as long as the corol; capsule three-celled, many-seeded: found in New Caledonia.

ARGUMENT, in rhetoric and logic, an inference drawn from premises, the truth of which is indisputable, or at least highly probable.

The arguments of orators receive particular denominations, according to the topics from whence they are derived; thus, we meet with arguments from affection, which interest the passions of the person to whom they are addressed; also with the arguments *a tuto, ad ignaviam, ab invidia*, &c.

In reasoning, Mr. Locke observes, that men ordinarily use four sorts of arguments. The first is to allege the opinions of men, whose parts and learning, eminency, power, or some other cause, has gained a name, and settled their reputation in the common esteem, with some kind of authority; this may be called *argumentum ad verecundiam*. Secondly, another way is to require the adversaries to admit what they allege as a proof, or to assign a better; this he calls *argumentum ad ignorantiam*. A third way is, to press a man with consequences, drawn from his own principles or concessions; this is known by the name of *argumentum ad hominem*. Fourthly, the using proofs drawn from any of the foundations of knowledge or probability; this he calls *argumentum ad judicium;* and observes, that it is the only one of all the four, that brings true instruction with it, and advances us in our way to knowledge. For, 1. It argues not another man's opinion to be right, because I, out of respect, or any other consideration, but that of conviction, will not contradict him. 2. It proves not another man to be in the right way, nor that I ought to take the same with him, because I know not a better. 3. Nor does it follow, that another man is in the right way, because he has shewn me, that I am in the wrong: this may dispose me, perhaps, for the reception of truth, but helps me not to it; that must come from proofs and arguments, and light arising from the nature of things themselves, not from my shamefacedness, ignorance, or error. See the articles REASON and REASONING.

ARGUMENT, in astronomy, denotes a known arch, by means of which we seek another one unknown.

The argument of the moon's latitude is her distance from the node; and the argument of inclination is an arch of a planet's orbit, intercepted between the ascending node and the place of the planet from the sun, numbered according to the succession of the signs.

ARGYTHAMNIA, in botany, a genus of plants of the Monoecia Tetrandria class and order. Essen. char. male calyx four-leaved; petals four: female calyx five-leaved; no corol; three styles, forked; capsule three-celled; seeds solitary. There is but a single species, a shrub, found in Jamaica, with a whitish bark; leaves oval; flowers axillary, on very short peduncles.

ARIANS, a denomination of Christians that take their name from Arius, a presbyter of Alexandria who flourished in the year 315. The propagation of this doctrine was the occasion of the celebrated council of Nice by Constantine, in the year

325. Arius acknowledged Christ to be God, in a subordinate sense, and considered his death to be a propitiation for sin. The Arians acknowledge, that the Son was the word, though they deny its being eternal, contending only that it had been created prior to all other beings. They maintain that Christ is not the eternal God; but, in opposition to the Unitarians, they contend for his pre-existence, a doctrine which they found on various passages of scripture, particularly these two, "before Abraham was, I am;" and "glorify me with the glory which I had with thee before the world was." Arians differ among themselves as to the extent of the doctrine. Some of them believe Christ to have been the Creator of the world, and on that account has a claim to religious worship; others admit of his pre-existence simply. Hence the appellations, high and low Arians. Dr. Clarke, Rector of St. James, in his "Scripture Doctrine of the Trinity;" Mr. Henry Taylor, Vicar of Portsmouth, in a work entitled, "Ben Mordicai's Apology;" Mr. Tomkins, in his "Mediator;" and Mr. Hopkins in his "Appeal to the Common Sense of all Christian People," have been deemed among the most able advocates of Arianism. Dr. Price has been one of the last writers in behalf of this doctrine: in his sermons "On the Christian Doctrine," will be found an able defence of low Arianism. See also a tract published in 1805, by Basanistes.

ARIES, in astronomy, a constellation of fixed stars, drawn on the globe in the figure of a ram. It is the first of the twelve signs of the zodiac, from which a twelfth part of the ecliptic takes its denomination. It is marked thus ♈, and consists of sixty-six stars.

ARISH, a long measure used in Persia, containing 3197 English feet.

ARISTA, among botanists, a long needle-like beard, which stands out from the husk of a grain of corn, grass, &c.

ARISTARCHUS, in biography, a celebrated Greek philosopher and astronomer, and a native of the city of Samos; but at what period he flourished is not certain. It must have been before the time of Archimedes, as some parts of his writings and opinions are cited by that author. He held the doctrine of Pythagoras as to the system of the world, but whether he lived before or after him is not known. He maintained that the sun and stars were fixed in the heavens, and that the earth moved in a circle about the sun, at the same time that it revolved about its own axis. He determined that the annual orbit of the earth, compared with the distance of the fixed stars, is but as a point. For these his opinions, which time has proved to be undeniably true, he was censured by his contemporaries, some of whom went about to prove that Greece ought to have punished Aristarchus for his heresy. This philosopher invented a peculiar kind of sun-dial, mentioned by Vitruvius. There is now extant only a treatise upon the magnitude and distance of the sun and moon, which was translated into Latin, and commented upon by Commandine, who published it with Pappus's explanations in 1572.

ARISTEA, in botany, a genus of plants of the Triandria Monogynia class and order. Petals six; style declined; stigma funnel-form, gaping; capsule inferior, many-seeded. There is but one species: a Cape plant, low; leaves veined and narrow; flowers in downy heads.

ARISTIDA, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is a bivalve subulated glume, of the length of the corolla; the corolla is a glume of one valve, opening longitudinally, hairy at the base, and terminated by three sub-equal patulous aristæ; the fruit is a connivent glume, containing a naked filiform single seed, of the length of the corolla. There are ten species.

ARISTOCRACY, a form of government where the supreme power is vested in the principal persons of the state, either on account of their nobility, or their capacity and probity.

Aristocracies, says Archdeacon Paley, are of two kinds; first, where the power of the nobility belongs to them in their collective capacity alone; that is, where, although the government reside in an assembly of the order, yet the members of the assembly, separately and individually, possess no authority or privilege beyond the rest of the community: such is the case in the constitution of Venice. Secondly, where the nobles are severally invested with great personal power and immunities, and where the power of the senate is little more than the aggregate power of the individuals who compose it: such was the case in the constitution of Poland. Of these two forms of government, the first is more tolerable than the last; for although many, or even all the members of a senate, should be so profligate as to abuse the authority of their

stations in the prosecution of private designs, yet, whilst all were not under a temptation to the same injustice, and having the same end to gain, it would still be difficult to obtain the consent of a majority to any specific act of oppression, which the iniquity of an individual might prompt him to propose: or, if the will were the same, the power is more confined; one tyrant, whether the tyranny reside in a single person, or a senate, cannot exercise oppression in so many places at the same time, as may be carried on by the dominion of a numerous nobility over their respective vassals and dependents. Of all species of domination, this is the most odious; the freedom and satisfaction of private life are more restrained and harassed by it, than by the most vexatious laws, or even by the lawless will of an arbitrary monarch, from whose knowledge, and from whose injustice, the greatest part of his subjects are removed by their distance, or concealed by their obscurity. An aristocracy of this kind has been productive, in several instances, of disastrous revolutions, and the people have concurred with the reigning prince, in exchanging their condition for the miseries of despotism. This was the case in Denmark about the middle of the seventeenth century, and more lately in Sweden. In England, also, the people beheld the depression of the barons, under the house of Tudor, with satisfaction, although they saw the crown acquiring thereby a power which no limitations, provided at that time by the constitution, were likely to confine.

From such events this lesson may be drawn: "That a mixed government, which admits a patrician order into the constitution, ought to circumscribe the personal privileges of the nobility, especially claims of hereditary jurisdiction and local authority, with a jealousy equal to the solicitude with which it provides for its own preservation." Paley's Princ. of Philos.

ARISTOLOCHIA, in botany, *birthwort*, a genus of plants of the Gynandria Hexandria class and order. Stigmata six; no calyx; corol one-petalled, tubular, tongue-shaped; capsule inferior, six-celled. There are 27 species, most foreign.

ARISTOTELIA, a genus of the Dodecandria Monogynia class and order: calyx five-leaved; petals five; style three-cleft; berry three-celled, with two seeds in each. One species, found in Chili, a shrub, leaves ever-green; flowers white in axillary racemes.

ARISTOTELIAN, something relating to Aristotle: thus we read of the Aristotelian philosophy, school, &c. See PERIPATETICS.

ARITHMETIC, the art of numbering; or, that part of mathematics, which considers the powers and properties of numbers, and teaches how to compute or calculate truly, and with expedition and ease. By some authors it is also defined the science of discrete quantity. It consists chiefly in the four great rules or operations of Addition, Subtraction, Multiplication, and Division. Concerning the origin and invention of arithmetic we have very little information; history fixes neither the author nor the time. Some knowledge, however, of numbers must have existed in the earliest ages of mankind. This knowledge would be suggested to them, whenever they opened their eyes, by their own fingers, and by their flocks and herds, and by the variety of objects that surrounded them. At first, indeed, their powers of numeration would be of very limited extent; and before the art of writing was invented, it must have depended on memory, or on such artificial helps, as might most easily be obtained. To their ten fingers they would, without doubt, have recourse in the first instance; and hence they would be naturally led to distribute numbers into periods, each of which consisted of ten units. This practice was common among all nations, the ancient Chinese, and an obscure people mentioned by Aristotle, excepted. But though some kind of computation must have commenced at a very early period, the introduction of arithmetic as a science, and the improvements it underwent, must, in a great degree, depend upon the introduction and establishment of commerce: and as commerce was gradually extended and improved, and other sciences were discovered and cultivated, arithmetic would be improved likewise. It is therefore probable, that if it was not of Tyrian invention, it must have been much indebted to the Phœnicians or Tyrians. Proclus, indeed, in his commentary on the first book of Euclid, says, that the Phœnicians, by reason of their traffic and commerce, were the first inventors of arithmetic; and Strabo also informs us, that in his time it was attributed to the Phœnicians. Others have traced the origin of this art to Egypt; and it has been a general opinion, sanctioned by the authorities of Socrates and Plato, that Theut or Thot was the inventor of numbers; that

from hence the Greeks adopted the idea of ascribing to their Mercury, corresponding to the Egyptian Theut or Hermes, the superintendance of commerce and arithmetic. With the Egyptians we ought also to associate the Chaldeans, whose astronomical disquisitions and discoveries, in which they took the lead, required a considerable acquaintance with arithmetic. From Asia it passed into Egypt, as Josephus says, by means of Abraham. Here it was greatly cultivated and improved; insomuch that a large part of the Egyptian philosophy and theology seems to have turned altogether upon numbers. Kircher shews, that the Egyptians explained every thing by numbers; Pythagoras himself affirming, that the nature of numbers pervades the whole universe, and that the knowledge of numbers is the knowledge of the deity. From Egypt, arithmetic was transmitted to the Greeks by Pythagoras and his followers; and among them it was the subject of particular attention, as we perceive in the writings of Euclid, Archimedes, and others; with the improvements derived from them, it passed to the Romans, and from them it came to us. The ancient arithmetic was very different from that of the moderns in various respects, and particularly in the method of notation. The Indians are at this time very expert in computing, by means of their fingers, without the use of pen and ink; and the natives of Peru, by the different arrangements of their grains of maize, surpass the European, aided by all his rules, with regard both to accuracy and dispatch. The Hebrews and Greeks, however, at a very early period, and after them also the Romans, had recourse to the letters of their alphabet for the representation of numbers. The Greeks, in particular, had two different methods: the first resembled that of the Romans, which is sufficiently known, as it is still used for distinguishing the chapters and sections of books, dates, &c. They afterwards had a better method, in which the first nine letters of the alphabet represented the first numbers from 1 to 9, and the next nine letters represented any number of tens, from 1 to 9, that is, 10, 20, &c. to 90. Any number of hundreds they expressed by other letters, supplying what they wanted by some other marks or characters: and in this order they proceeded, using the same letters again, with different marks to express thousands, tens of thousands, hundreds of thousands, &c.; thus approaching very near to the more perfect decuple scale of progression used by the Arabians, who acknowledge, as some have said, that they received it from the Indians. Archimedes also in his "Arenarius," used a particular scale and notation of his own. In the second century of the christian era, Ptolemy is supposed to have invented the sexagesimal numeration and notation, and this method is still used by astronomers and others, for the subdivision of the degrees of circles. These several modes of notation above recited, were so operose and inconvenient, that they limited the extent, and restrained the progress of arithmetic, so that it was applicable with great difficulty and embarrassment to the other sciences, which required its assistance. The Greeks, if we except Euclid, who in his elements furnished many plain and useful properties of numbers, and Archimedes in his Arenarius, contributed little to the advancement of this science towards perfection. From Boethius we learn, that some Pythagoreans had invented and employed, in their calculations, nine particular characters, whilst others used the ordinary signs, namely, the letters of the alphabet. These characters he calls apices; and they are said greatly to resemble the ancient Arabic characters, which circumstance suggests a suspicion of their authenticity. Indeed, the MSS. of Boethius, in which these characters, resembling those of the Arabian arithmetic, are found, not being more ancient than three or four centuries, confirm the opinion that they are the works of a copyist. Upon the whole, this treatise of Boethius does not warrant our rejecting the commonly received system with regard to the origin of our arithmetic; but if we suppose that the Arabians derived their knowledge of it from the Indians, it is more probable that it was one of the inventions which Pythagoras spread among the Indians, than that those persons should have obtained it from the Greeks.

The introduction of the Arabian or Indian notation into Europe, about the tenth century, made a material alteration in the state of arithmetic; and this, indeed, was one of the greatest improvements which this science had received since the first discovery of it. This method of notation, now universally used, was probably derived originally from the Indians by the Arabians, and not, as some have supposed, from the Greeks; and it was brought from the Arabians into Spain by the Moors or Saracens, in the tenth century. Gerbert, who was afterwards Pope, under the name of Silves-

ter II. and who died in the year 1,003, brought this notation from the Moors of Spain into France, long before the time of his death, or, as some think, about the year 960; and it was known among us in Britain, as Dr. Wallis has shewn, in the beginning of the eleventh century, if not somewhat sooner. As literature and science advanced in Europe, the knowledge of numbers was also extended, and the writers in this art were very much multiplied. The next considerable improvement in this branch of science, after the introduction of the numeral figures of the Arabians or Indians, was that of decimal parts, for which we are indebted to Regiomontanus; who about the year 1464, in his book of "Triangular Canons," set aside the sexagesimal subdivisions, and divided the radius into 60,000,000 parts; but afterwards he altogether waved the ancient division into 60, and divided the radius into 10,000,000 parts; so that if the radius be denoted by 1, the sines will be expressed by so many places of decimal fractions as the cyphers following 1. This seems to have been the first introduction of decimal parts. To Dr. Wallis we are principally indebted for our knowledge of circulating decimals, and also for the arithmetic of infinites. The last, and perhaps, with regard to its extensive application and use, the greatest improvement which the art of computation ever received, was that of logarithms, which we owe to Baron Neper or Napier, and Mr. Henry Briggs. See LOGARITHMS.

ARITHMETIC, *theoretical*, is the science of the properties, relations, &c. of numbers, considered abstractedly, with the reasons and demonstrations of the several rules. Euclid furnishes a theoretical arithmetic, in the seventh, eighth, and ninth books of his elements.

ARITHMETIC, *practical*, is the art of numbering or computing; that is, from certain numbers given, of finding certain others, whose relation to the former is known. As, if two numbers, 10 and 5, are given, and we are to find their sum, which is 15, their difference 5, their product 50, their quotient 2.

The method of performing these operations generally we shall now proceed to shew, reserving for the alphabetical arrangement those articles which, though dependent on the first four rules, do not necessarily make a fundamental part of arithmetic.

ADDITION.

Addition is that operation by which we find the amount of two or more numbers. The method of doing this in simple cases is obvious, as soon as the meaning of number is known, and admits of no illustration. A young learner will begin at one of the numbers, and reckon up as many units separately as there are in the other, and practice will enable him to do it at once. It is impossible, strictly speaking, to add more than two numbers at a time. We must first find the sum of the first and second, then we add the third to that number, and so on. However, as the several sums obtained are easily retained in the memory, it is neither necessary nor usual to mark them down. When the numbers consist of more figures than one, we add the units together, the tens together, and so on. But if the sum of the units exceed ten, or contain ten several times, we add the number of tens it contains to the next column, and only set down the number of units that are over. In like manner we carry the tens of every column to the next higher. And the reason of this is obvious from the value of the places; since an unit in any higher places signifies the same thing as ten in the place immediately lower.

Rule. Write the numbers distinctly, units under units, tens under tens, and so on. Then reckon the amount of the right-hand column; if it be under ten mark it down; if it exceed ten mark the units only, and carry the tens to the next place. In like manner carry the tens of each column to the next, and mark down the full sum of the left-hand column.

	Ex. 1.	*Ex* 2.	*Ex.* 3.
	432	10467530	457974683217
	215	37604	2919792935
	394	63254942	47374859621
	260	43219	24354642
	409	856757	925572199991
	245	2941275	473214
	132	459	499299447325
	694	41210864	10049431
	317	52321975	41
	492	4686	5498936009
	243	43264353	943948999274
Ans.	3833		

As it is of great consequence in business to perform addition readily and exactly, the learner ought to practise it till it become

quite familiar. If the learner can readily add any two digits he will soon add a digit to a higher number with equal ease. It is only to add the unit place of that number to the digit, and if it exceed ten, it raises the amount accordingly. Thus, because 8 and 6 are 14, 48 and 6 are 54. It will be proper to mark down under the sums of each column, in a small hand, the figure that is carried to the next column. This prevents the trouble of going over the whole operation again, in case of interruption or mistake. If you want to keep the account clean, mark down the sum and figure you carry on a separate paper, and after revising them, transcribe the sum only. After some practice we ought to acquire the habit of adding two or more figures at one glance. This is particularly useful when two figures which amount to 10, as 6 and 4, or 7 and 3, stand together in the column. Every operation in arithmetic ought to be revised, to prevent mistakes; and as one is apt to fall into the same mistake if he revise it in the same manner he performed it, it is proper either to alter the order, or else to trace back the steps by which the operation advanced, which will lead us at last to the number we began with. When the given number consists of articles of different value, as pounds, shillings, and pence, or the like, which are called different denominations, the operations in arithmetic must be regulated by the value of the articles. We shall give here a few of the most useful tables for the learner's information, referring for other information to the articles, Measures, Weights, &c.

I. STERLING MONEY.

4 Farthings = 1 penny, marked *d.*
12 Pence = 1 shilling, *s.*
20 Shillings = 1 pound, *£.*

II. TROY WEIGHT.

24 Grains = 1 pennyweight, *dwt.*
20 Pennyweights = 1 ounce, *oz.*
12 Ounces = 1 pound, *lb.*

III. AVOIRDUPOIS WEIGHT.

16 Drams = 1 ounce, *oz.*
16 Ounces = 1 pound, *lb.*
18 Pounds = 1 quarter, *qr.*
4 Quarters = 1 hundred weight, *C.*
20 Hundred weight = 1 ton, *T.*

IV. ENGLISH DRY MEASURE.

2 Pints = 1 quart.
4 Quarts = 1 gallon.
2 Gallons = 1 peck.
4 Pecks = 1 bushel.
8 Bushels = 1 quarter.

V. LONG MEASURE.

12 Inches = 1 foot.
3 Feet = 1 yard.
$5\frac{1}{2}$ Yards = 1 pole.
40 Poles = 1 furlong.
8 Furlongs = 1 mile.
3 Miles = 1 league.

VI. ENGLISH LAND MEASURE.

$30\frac{1}{4}$ Square yards = 1 pole or perch.
40 Poles = 1 rood.
4 Roods = 1 acre.

VII. CLOTH MEASURE.

$2\frac{1}{4}$ Inches = 1 nail.
4 Nails = 1 quarter.
4 Quarters = 1 yard.
5 Quarters = 1 English ell.

Rule for Compound Addition. Arrange like quantities under like, and carry according to the value of the higher place. When you add a denomination which contains more columns than one, and from which you carry to the higher by 20, 30, or any even number of tens, first add the units of that column and mark down their sum, carrying the tens to the next column; then add the tens and carry to the higher denomination, by the number of tens that it contains of the lower. For example, in adding shillings carry by 10 from the units to the tens, and by 2 from the tens to the pounds. If you do not carry by an even number of tens, first find the complete sum of the lower denomination, then inquire how many of the higher that sum contains, and carry accordingly, and mark the remainder, if any, under the column. For example, if the sum of column of pence be 43, which is three shillings and seven-pence, mark 7 under the pence column, and carry 3 to that of the shillings.

Examples in sterling Money.

£.	s.	d.	£.	s	d.
215	3	9	169	16	10
172	18	4	36	12	$9\frac{3}{4}$
645	7	7	54	7	6
737	2	3	30	0	$1\frac{1}{4}$
35	3	9	7	19	6
9	0	7	707	19	11
1814	16	3	1006	16	8

T.	C.	qr.	lb.	T	C.	qr.	lb.
–	14	1	16	6	3	–	19
2	18	1	16	5	7	3	26
–	1	2	27	3	2	2	—
3	1	–	10	4	3	1	10
–	17	2	24	–	18	1	12
–	15	3	18	1	1	1	1
4	6	–	5	5	3	–	7
12	15	1	4	25	19	2	19

Examples for Practice.

MONEY.

£.	s.	d.	£.	s.	d.	£.	s.	d.
257	1	$5\frac{1}{2}$	525	2	$4\frac{1}{4}$	21	14	$7\frac{1}{4}$
734	3	$7\frac{3}{4}$	179	3	5	75	16	0
595	5	3	250	4	$7\frac{1}{4}$	79	2	$4\frac{1}{4}$
152	14	$7\frac{1}{2}$	975	3	$5\frac{1}{4}$	57	16	$5\frac{1}{2}$
207	5	4	254	5	7	26	13	$8\frac{3}{4}$
798	16	$7\frac{3}{3}$	379	4	$5\frac{3}{4}$	54	2	7

£.	s.	d.	£.	s.	d.	£.	s.	d.
127	4	$7\frac{1}{2}$	261	17	$1\frac{1}{4}$	31	1	$1\frac{1}{2}$
525	3	5	379	13	5	75	13	1
271	0	5	257	16	$7\frac{3}{4}$	39	19	$6\frac{1}{4}$
524	9	1	184	13	5	97	17	$3\frac{1}{4}$
379	4	$3\frac{1}{2}$	725	2	$3\frac{1}{4}$	36	13	5
215	5	$8\frac{3}{4}$	359	6	3	24	16	$3\frac{1}{4}$

TROY WEIGHT.

lb.	oz.	dwt.	lb.	oz.	dwt.	gr.
7	1	2	5	2	15	22
3	2	17	3	11	17	14
5	1	15	3	7	15	19
7	10	11	9	1	13	21
2	7	13	3	9	7	23
3	11	16	5	2	15	17

AVOIRDUPOIS WEIGHT.

lb.	oz.	dr.	t.	cwt.	qr.	lb.
152	13	15	7	17	2	12
272	14	10	5	5	3	14
303	15	11	2	4	1	17
255	10	4	3	18	2	19
173	6	2	7	9	3	20
625	13	13	8	5	1	24

APOTHECARIES WEIGHT.

℔	℥	ʒ	℈	℔	℥	ʒ	℈	gr.
17	10	7	1	7	2	1	0	12
9	5	2	2	3	1	7	1	17
27	11	1	2	9	10	2	0	14
9	5	6	1	7	5	7	1	15
37	10	5	2	3	9	5	2	13
49	—	7	0	7	1	4	1	18

CLOTH MEASURE.

yd.	qr.	n.	EE.	qr.	n.
135	3	3	272	2	1
70	2	2	152	1	2
95	3	0	79	0	1
176	1	3	156	2	0
26	0	1	79	3	1
279	2	1	154	2	1

LONG MEASURE.

yd.	feet.	in.	bar.	lea.	m.	fur.	p.
225	1	9	1	72	2	1	19
171	0	3	2	27	1	7	22
52	2	3	2	35	2	5	31
397	0	10	1	79	0	6	12
154	2	7	2	51	1	6	17
137	1	4	1	72	0	5	21

LAND MEASURE.

a.	r.	p.	a.	r.	p.
726	1	31	1232	1	14
219	2	17	327	0	19
1455	3	14	131	2	15
879	1	21	1219	1	18
1195	2	14	459	2	17

WINE MEASURE.

hhds.	gal.	qts.	T.	hhds.	gal.	qts.
31	57	1	14	3	27	2
97	18	2	19	2	56	3
76	13	1	17	0	39	2
55	46	2	75	2	16	1
87	38	3	54	1	19	2
55	17	1	97	3	54	3

ALE AND BEER MEASURE.

A.B. fir. gal.	*hhds. gal. qr.*
25 .. 2 .. 7	76 .. 51 .. 2
17 .. 3 .. 5	57 .. 3 .. 3
96 .. 2 .. 6	97 .. 27 .. 3
75 .. 1 .. 4	22 .. 17 .. 2
96 .. 3 .. 7	32 .. 19 .. 3
75 .. 0 .. 5	55 .. 38 .. 3

DRY MEASURE.

ch. bu. pks.	*lasts. weys. qts. bu. pks.*
75 .. 2 .. 1	38 .. 1 .. 4 .. 5 .. 3
41 .. 24 .. 1	47 .. 1 .. 3 .. 6 .. 2
92 .. 16 .. 1	62 .. 0 .. 2 .. 4 .. 3
70 .. 13 .. 2	45 .. 1 .. 4 .. 3 .. 3
54 .. 17 .. 3	78 .. 1 .. 1 .. 2 .. 2
79 .. 25 .. 1	29 .. 1 .. 3 .. 6 .. 2

TIME.

w. d. h.	*w. d. h. m. sec.*
71 .. 3 .. 11	57 .. 2 .. 15 .. 42 .. 41
51 .. 2 .. 9	95 .. 3 .. 21 .. 27 .. 51
76 .. 0 .. 21	76 .. 0 .. 15 .. 37 .. 28
95 .. 3 .. 21	53 .. 2 .. 21 .. 42 .. 27
79 .. 1 .. 15	98 .. 2 .. 18 .. 47 .. 38

When one page will not contain the whole account, we add the articles it contains, and write against their sum *carried forward*, and we begin the next page with the sum of the the foregoing, writing against it *brought forward*. When the articles fill several pages, and their whole sum is known, which is the case in transcribing accounts, it is best to proceed in the following manner: add the pages, placing the sums in a separate paper; then add the sums, and if the amount of the whole be right, it only remains to find what number should be placed at the foot and top of the pages. For this purpose, repeat the sum of the first page on the same line; add the sums of the first and second, placing the amount in a line with the second; to this add the sum of the third, placing the amount in a line with the third. Proceed in the like manner with the others; and if the last sum corresponds with the amount of the page, it is right. These sums are transcribed at the foot of the respective pages, and tops of the following ones.

SUBTRACTION.

Subtraction is the operation by which we take a lesser number from a greater, and find their difference. It is exactly opposite to addition, and is performed by learners in a like manner, beginning at the greater, and reckoning downwards the units of the lesser. The greater is called the minuend, and the lesser the subtrahend. If any figure of the subtrahend be greater than the corresponding figure of the minuend, we add ten to that of the minuend, and having found and marked the difference, we add one to the next place of the subtrahend. This is called borrowing ten. The reason will appear, if we consider that when two numbers are equally increased by adding the same to both, their difference will not be altered. When we proceed as directed above, we add ten to the minuend, and we likewise add one to the higher place of the subtrahend, which is equal to ten of the lower place.

Rule.—Subtract units from units, tens from tens, and so on. If any figure of the subtrahend be greater than the corresponding one of the minuend, borrow ten.

Examples.

Minuend	173694	733641
Subtrahend ...	21453	379235
Remainder....	152241	359406

To prove subtraction, add the subtrahend and remainder together; if their sum be equal to the minuend, the account is right. Or subtract the remainder from the minuend. If the difference be equal to the subtrahend, the account is right.

Rule for Compound Subtraction. Place like denominations under like, and borrow, when necessary, according to the value of the higher place.

Examples.

£. s. d.	*cwt. qrs. lb.*
146 .. 3 .. 3	12 .. 3 .. 19
58 .. 7 .. 6	4 .. 3 .. 24
87 .. 15 .. 9	7 .. 3 .. 23

Examples for Practice.

TROY WEIGHT.

	lb. oz. dt. gr.	*lb. oz. dt. gr.*
Bought	52 .. 1 .. 7 .. 2	7 .. 2 .. 2 .. 7
Sold....	39 .. 0 .. 15 .. 7	5 .. 7 .. 1 .. 5
Unsold		

AVOIRDUPOIS WEIGHT.

lb. oz. dr.	*cwt. qrs. lb.*	*T. cwt. qrs. lb.*
35 .. 10 .. 5	35 .. 1 .. 21	21 .. 1 .. 2 .. 7
29 .. 12 .. 7	25 .. 1 .. 10	9 .. 1 .. 3 .. 5

APOTHECARIES WEIGHT.

℔ ℥ ʒ ℈	℔ ℥ ʒ ℈ *gr.*
5 .. 2 .. 1 .. 0	9 .. 7 .. 2 .. 1 .. 13
2 .. 5 .. 2 .. 1	5 .. 7 .. 3 .. 1 .. 18

CLOTH MEASURE.

FE. qrs. n.	*yds. qrs. n.*	*EE. qrs. n.*
35 .. 2 .. 2	71 .. 1 .. 2	35 .. 2 .. 1
17 .. 2 .. 1	3 .. 2 .. 1	14 .. 3 .. 2

LONG MEASURE.

yds. ft. in. bar.	*leag. mi. fur. po.*
107 .. 2 .. 10 .. 1	147 .. 2 .. 6 .. 29
78 .. 2 .. 11 .. 2	58 .. 2 .. 7 .. 33

LAND MEASURE.

a. r. p.	*a. r. p.*
175 .. 1 .. 27	325 .. 2 .. 1
59 .. 0 .. 27	279 .. 3 .. 5

WINE MEASURE.

hhd. gal. qts. pi.	*tun hhd. gal. qts.*
47 .. 47 .. 2 .. 1	42 .. 2 .. 37 .. 2
28 .. 59 .. 3 .. 0	17 .. 3 .. 49 .. 3

ALE AND BEER MEASURE.

AB. fir. gal.	*BB. fir. gal.*	*hhd. gal. qts.*
25 .. 1 .. 2	37 .. 2 .. 1	27 .. 27 .. 1
21 .. 1 .. 5	25 .. 1 .. 7	12 .. 50 .. 2

DRY MEASURE.

qu. bu. p.	*qu. bu. p.*	*ch. bu. p.*
72 .. 1 .. 2	65 .. 2 .. 1	79 .. 3 .. 0
35 .. 2 .. 3	57 .. 2 .. 3	54 .. 7 .. 1

TIME.

yrs. mo. we. da.	*ho. min. sec.*
79 .. 8 .. 2 .. 4	34 .. 42 .. 45
23 .. 9 .. 3 .. 5	19 .. 53 .. 47

The reason for borrowing is the same as in simple subtraction. Thus, in subtracting pence, we add 12 pence when necessary to the minuend, and at the next step we add one shilling to the subtrahend. When there are two places in the same denomination, if the next higher contain exactly so many tens, it is best to subtract the units first, borrowing ten when necessary; and then subtract the tens, borrowing, if there is occasion, according to the number of tens in the higher denomination. If the value of the higher denomination be not an even number of tens, subtract the units and tens at once, borrowing according to the value of the higher denomination. It is often necessary to place the sums in different columns, in order to exhibit a clear view of what is required. For instance, if the values of several parcels of goods are to be added, and each parcel consists of several articles, the particular articles should be placed in an inner column, and the sum of each parcel extended to the outer column, and the total added there. If any person be indebted an account, and has made some partial payments, the payments must be placed in an inner column, and their sum extended under that of the account in the outer column, and subtracted there: the following examples will explain cur meaning:

	£.	s.	d.
Borrowed........	25107 ..	15 ..	7
	375 ..	5 ..	5¼
Paid	259 ..	2 ..	7½
at	359 ..	13 ..	4¾
different	523 ..	17 ..	3
times	274 ..	15 ..	7¼
	325 ..	13 ..	5
Paid in all........	2118 ..	7 ..	8¾
Remains to pay	22989 ..	7 ..	10½

	£.	s.	d.
Lent........	550156 ..	1 ..	6
	171 ..	13 ..	7¼
Received	359 ..	15 ..	3
at	475 ..	13 ..	9¾
several	527 ..	15 ..	0¼
payments	272 ..	16 ..	5
	150 ..	— ..	0

MULTIPLICATION.

In Multiplication two numbers are given, and it is required to find how much the first

amounts to, when reckoned as many times as there are units in the second. Thus 8 multiplied by 5, or 5 times 8, is 40. The given numbers (8 and 5) are called factors; the first (8) the multiplicand; the second (5) the multiplier; and the amount (40) the product. This operation is nothing else than addition of the same number several times repeated. If we mark 8 five times under each other, and add them, the sum is 40: but as this kind of addition is of frequent and extensive use, in order to shorten the operation, we mark down the number only once, and conceive it to be repeated as often as there are units in the multiplier. For this purpose, the learner must be thoroughly acquainted with the following multiplication table, which is composed by adding each digit 12 times.

TABLE.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

In this table the multiplicand figures are in the upper horizontal row; the multipliers are in the left hand column, and the products will be found under the multiplicand, and in the same row with the multiplier: thus 9 times 11 are 99; the 99 will be found in the column under the 11, and in the same horizontal row with the 9, among the multipliers.

If both factors be under 12, the table exhibits the product at once. If the multiplier only be under 12, we begin at the unit place, and multiply the figures in their order, carrying the tens to the higher place, as in addition.

Example.

$$\begin{array}{rr} & 76859 \text{ multiplied by } 4, \\ & 4 \\ \hline \text{Ans.} & 307436 \end{array}$$

or, 76859 added 4 times.

$$\begin{array}{rl} & 76859 \\ & 76859 \\ & 76859 \\ & 76859 \\ \hline \text{Ans.} & 307436 \text{ the same as before.} \end{array}$$

If the multiplier be 10, we annex a cypher to the multiplicand. If the multiplier be 100, we annex two cyphers; and so on. The reason is obvious, from the use of cyphers in notation. If the multiplier be any digit, with one or more cyphers on the right hand, we multiply by the figure, and annex an equal number of cyphers to the product.

Thus, if it be required to multiply by 60, we first multiply by 6, and then annex a cypher. It is the same thing as to add the multiplicand 60 times; and this might be done by writing the account at large, dividing the column into 10 parts of 6 lines, finding the sum of each part, and adding these ten sums together. If the multiplier consist of several significant figures, we multiply separately by each, and add the products. It is the same as if we divided a long account of Addition into parts corresponding to the figures of the multiplier.

Example.

To multiply 7329 by 365.

$$\begin{array}{rrr} 7329 & 7329 & 7329 \\ 5 & 60 & 300 \\ \hline 36645 & 439740 & 2198700 \end{array}$$

$$\begin{array}{rcl} 36645 & = & 5 \text{ times.} \\ 439740 & = & 60 \text{ times.} \\ 2198700 & = & 300 \text{ times.} \\ \hline 2675085 & = & 365 \text{ times.} \end{array}$$

It is obvious that 5 times the multiplicand added to 60 times, and to 300 times, the same must amount to the product required. In practice, we place the products at once under each other; and as the cyphers arising from the higher places of the multiplier are lost in the addition, we omit them. Hence may be inferred the following

Rule. Place the multiplier under the multiplicand, and multiply the latter successively by the significant figures of the former; by placing the right-hand figure of

each product under the figure of the multiplier from which it arises; then add the product.

Example.

7329	93956
365	8704
36645	375824
43974	657692
21987	751648
2675085	817793024

A number which cannot be produced by the multiplication of two others, is called a prime number; as 3, 5, 7, 11, and many others. A number which may be produced by the multiplication of two or more smaller ones, is called a composite number. For example, 27, which arises from the multiplication of 9 by 3; and these numbers (9 and 3) are called the component parts of 27.

1. If the multiplier be a composite number, we may multiply successively by the component parts.

Example.

7638	by 45, or 5 times 9	7638
45		9
38190		68742
30552		5
343710		343710

Because the second product is equal to five-times the first, and the first is equal to nine-times the multiplicand, it is obvious that the second product must be five-times-nine, or forty-five-times as great as the multiplicand.

2. If the multiplier be 5, which is the half of 10, we may annex a cypher, and divide by 2. If it be 25, which is the fourth part of 100, we may annex two cyphers, and divide by 4. Other contractions of the like kind will readily occur to the learner.

3. To multiply by 9, which is one less than 10, we may annex a cypher, and subtract the multiplicand from the number it composes. To multiply by 99,999, or any number of 9's, annex as many cyphers, and substract the multiplicand. The reason is obvious; and a like rule may be found, though the unit place be different from 9. Multiplication is proved by repeating the operation, using the multiplier for the multiplicand, and the multiplicand for the multiplier. It may also be proved by division, or by casting out the 9's; of which afterwards; and an account, wrought by any contraction, may be proved by performing the operation at large, or by a different contraction.

The following examples will serve to exercise a learner in this rule.

1.	Multiply	87945	by	2
2.	....	947321	by	3
3.	....	7914735	by	4
4.	....	49782147	by	5
5.	....	5721321	by	6
6.	....	4794321	by	7
7.	....	7654319	by	8
8.	....	3721478	by	9
9.	....	4783219	by	11
10.	....	4733218	by	12
11.	....	4783882	by	21
12.	....	2179929	by	32
13.	....	921577394	by	84
14.	....	217431473	by	132
15.	....	47314796	by	141
16.	....	217932173	by	96
17.	....	314731271	by	121
18.	....	4796427	by	238
19.	....	470621472	by	432
20.	....	479621473	by	453
21.	....	479632179	by	473
22.	....	473457896	by	963
23.	....	943446788	by	987
24.	....	49416739	by	298
25.	....	479327	by	403
26.	....	4932149	by	3028
27.	....	4731214	by	3008
28.	....	49496	by	4009
29.	....	97213217	by	904
30.	....	49321729	by	706
31.	....	4932920	by	720
32.	....	493679310	by	970
33.	....	7893470	by	760
34.	....	479379340	by	900

COMPOUND MULTIPLICATION.

I. If the multiplier do not exceed 12, the operation is performed at once, beginning at the lowest place, and carrying according to the value of the place.

Examples.

£. s. d.	*cwt. qr.* ℔.
13 .. 6 .. 7	12 .. 2 .. 8
9	5
119 .. 19 .. 3	62 .. 3 .. 12

A. R. P.	℔. *oz. dwt.*
13 .. 3 .. 18	7 .. 5 .. 9
6	12
83 .. 0 .. 28	89 .. 5 .. 8

II. If the multiplier be a composite number, whose component parts do not exceed 12, multiply first by one of these parts, then multiply the product by the other. Proceed in the same manner if there be more than two.

	£.	s.	d.	
Ex. 1.	256 ..	4 ..	$7\frac{1}{2}$	× by 72 = 12 × 6
			12	
	3074 ..	15 ..	6	
			6	
Ans.	18448 ..	13 ..	0	

	£.	s.	d.	
Ex. 2.	355 ..	13 ..	$7\frac{3}{4}$	× 180 = 12 × 5 × 3
			12	
	4268 ..	3 ..	9	
			5	
	21340 ..	18 ..	9	
			3	
Ans.	64022 ..	16 ..	3	

The component parts will answer in any order; it is best, however, when it can be done, to take them in such order as may clear off some of the lower places in the first multiplication, as is done in both the examples. The operation may be proved by taking the component parts in a different order, or by dividing the multiplier in a different manner.

III. If the multiplier be a prime number, multiply first by the composite number next lower, then by the difference, and add the products.

	£.	s.	d.	
Ex.	576 ..	4 ..	$9\frac{1}{2}$	× 87 = 12 × 7 + 3
			12	
	6914 ..	17 ..	6	
			7	
	48404 ..	2 ..	6	
	1728 ..	14 ..	$4\frac{1}{2}$	= 3 times.
Ans.	50122 ..	16 ..	$10\frac{1}{2}$	

Here we multiply the given sum by 12 and 7, because 12 × 7 = 84, the answer is 48404*l.* 2*s.* 6*d.* we then multiply the given sum by 3, which gives 1728*l.* 14*s.* $4\frac{1}{2}$*d.* these sums added together give the true answer.

IV. If there be a composite number a little larger than the multiplier, we may multiply by that number, and by the difference, and subtract the second product from the first.

	£.	s.	d.	
Ex.	3976 ..	10 ..	$4\frac{1}{2}$	× 34 = 6 × 6 − 2
			6	
	23861 ..	2 ..	3	
			6	
	143166 ..	13 ..	6	
	7953 ..	0 ..	9	
Ans.	135213 ..	12 ..	9	

We multiply the given sum by 6 and 6, because 6 × 6 = 36; the answer is 143166*l.* 13*s.* 6*d.* we then multiply the sum by 2, and subtracting that product from the former we get the true answer.

V. If the multiplier be large, multiply by 10, and multiply the product again by 10; by which means you obtain an hundred times the given number. If the multiplier exceed 1000, multiply by 10 again, and continue it farther if the multiplier require it; then multiply the given number by the unit place of the multiplier; the first product by ten place, the second product by the hundred place, and so on. Add the products thus obtained together.

Examples. Multiply 35*l.* 14*s.* $8\frac{1}{2}$*d.* by 4555.

£.	s.	d.		£.	s.	d.	
35 ..	14 ..	$8\frac{1}{2}$	× 5 =	178 ..	13 ..	$6\frac{1}{2}$	= 5 times.
		10					
357 ..	7 ..	1	× 5 =	1786 ..	15 ..	5	= 50 times.
		10					
3575 ..	10 ..	10	× 5 =	17877 ..	14 ..	2	= 500 times.
		10					
35755 ..	8 ..	4	× 4 =	143021 ..	13 ..	4	= 4000 times.
			Ans.	162864 ..	16 ..	$5\frac{1}{2}$	= 4555 times.

The following examples will furnish the learner with practice.

1. 21 ells of Holland, at 7*s*. 8½*d*. *per* ell.
Ans. £8 .. 1 .. 10½.

2. 35 firkins of butter, at 15*s* 3½*d*. *per* firkin. *Ans.* £26 .. 15 .. 2½.

3. 75℔. of nutmegs, at 7*s*. 2¾*d* *per* ℔.
Ans. £27 .. 2 .. 2¼.

4. 37 yards of tabby, at 9*s*. 7*d*. *per* yard.
Ans. £17 .. 14 .. 7.

5. 97 cwt. of cheese, at 1*l*. 5*s*. 3*d*. *per* cwt. *Ans.* £122 .. 9 .. 3.

6. 43 dozen of candles, at 6*s*. 4*d*. *per* doz.
Ans. £13 .. 12 .. 4.

7. 127 ℔ of bohea tea, at 12*s*. 3*d*. *per* ℔.
Ans. £77 .. 15 .. 9.

8. 135 gallons of rum, at 7*s*. 5*d*. *per* gallon. *Ans.* £50 .. 1 .. 3.

9. 74 ells of diaper, at 1*s*. 4½*d*. *per* ell.
Ans. £5 .. 1 .. 9.

The use of multiplication is to compute the amount of any number of equal articles, either in respect of measure, weight, value, or any other consideration. The multiplicand expresses how much is to be reckoned for each article, and the multiplier expresses how many times that is to be reckoned. As the multiplier points out the number of articles to be added, it is always an abstract number, and has no reference to any value or measure whatever. It is therefore quite improper to attempt the multiplication of shillings by shillings, or to consider the multiplier as expressive of any denomination. The most common instances in which the practice of this operation is required, are to find the amount of any number of parcels, to find the value of any number of articles, to find the weight or measure of a number of articles, &c. This computation for changing any sum of money, weight, or measure, into a different kind, is called Reduction. When the quantity given is expressed in different denominations, we reduce the highest to the next lower, and add thereto the given number of that denomination; and proceed in like manner till we have reduced it to the lowest denomination.

Ex. Reduce 58*l*. 4*s*. 2½*d*. into farthings.

```
        58 .. 4 .. 2½
        20
      1164 = shillings in £58 .. 4.
        12
     13970 = pence in £58 .. 4 .. 2.
         4
Ans. 55882 = farthings in £58 .. 4 .. 2½.
```

DIVISION.

In division two numbers are given, and it is required to find how often the former contains the latter. Thus it may be asked how often 21 contains 7, and the answer is exactly 3 times. The former given number (21) is called the dividend; the latter (7) the divisor; and the number required (3) the quotient. It frequently happens that the division cannot be completed exactly without fractions. Thus it may be asked, how often 8 is contained in 19? the answer is twice, and the remainder of 3. This operation consists in subtracting the division from the dividend, and again from the remainder, as often as it can be done, and reckoning the number of subtractions. As this operation, performed at large, would be very tedious, when the quotient is a high number, it is proper to shorten it by every convenient method; and, for this purpose, we may multiply the divisor by any number whose product is not greater than the dividend, and so subtract it twice or thrice, or oftener, at the same time. The best way is to multiply it by the greatest number, that does not raise the product too high, and that number is also the quotient. For example, to divide 45 by 7, we inquire what is the greatest multiplier for 7, that does not give a product above 45; and we shall find that it is 6; and 6 times 7 is 42, which, subtracted from 45, leaves a remainder of 3. Therefore 7 may be subtracted 6 times from 45; or, which is the same thing, 45 divided by 7, gives a quotient of 6, and a remainder of 3. If the divisor do not exceed 12, we readily find the highest multiplier that can be used from the multiplication table. If it exceed 12, we may try any multiplier that we think will answer. If the product be greater than the dividend, the multiplier is too great; and if the remainder, after the product is subtracted from the dividend, be greater than the divisor, the multiplier is too small. In either of these cases, we must try another. But the attentive learner, after some practice, will generally hit on the right multiplier at first. If the divisor be contained oftener than ten times in the dividend, the operation requires as many steps as there are figures in the quotient. For instance, if the quotient be greater than 100, but less than 1000, it requires 3 steps.

Example. Divide 48764312 by 9.

```
      9)48764312
Ans.    5418256 — 8 remainder.
              9
Proof  48764312
```

In this example we say the 9's in 48, 5 times and 3 over; put down 5 and carry 3, and say 9's in 37, 4 times and 1 over; put down 4 and carry 1; 9's in 16, 1 and 7 over; and so on to the end; there is 8 over as a remainder. The proof is obtained by multiplying the quotient by the divisor, and taking in the remainder: this is called "Short Division," of which we give for practice the following examples.

1. Divide 4732157 by 2
2. .... 342351742 by 3
3. .... 435234174 by 4
4. .... 49491244 by 5
5. .... 94942484 by 6
6. .... 4434983 by 7
7. .... 994357971 by 8
8. .... 449246812 by 9
9. .... 557779991 by 11
10. .... 665594765 by 12

The second part of this rule is called "Long Division," for the practice of which we give these directions.

Count the same number of figures on the left of the dividend as the divisor has in it; try whether the divisor be contained in this number, if not contained therein, take another dividend figure and then try how many times the divisor is contained in it.

To find more easily how many times the divisor is contained in any number; cast away in your mind all the figures in the divisor except the left hand one, and cast away the same number from the dividend figures as you did from the divisor: the two numbers, being thus made small, will be easily estimated.

If the product of the divisor with the quotient figure be greater than the number from which it should be taken, the number thought of was too great, the multiplying must be rubbed out, and a less quotient figure used.

When after the multiplying and subtracting, the remainder is more than the divisor, the quotient figure was too small, the work must be rubbed out, and a larger number supplied.

Example.

Divide 87654213, by 987.

```
987) 87654213 (88808 Quotient.
     7896
     .8694
      7896
      .7982
       7896
        .8613
        .7896
         .717 remainder.

          88808
            987
         621663
        710465
       799279
       87654213 proof
```

Ans. $88808\frac{717}{987}$.

To prove the truth of the sum, I multiply the quotient by the divisor, and take in the remainder, which gives the original dividend.

Examples for Practice.

1. Divide 721354 by 21
2. .... 57214372 by 42
3. .... 67215731 by 63
4. .... 802594321 by 84
5. .... 965314162 by 89
6. .... 43219875 by 674
7. .... 57397296 by 714
8. .... 496521 by 2798
9. .... 49446327 by 796
10. .... 47324967 by 699
11. .... 275472734 by 497
12. .... 43927483 by 586
13. .... 96543245 by 763
14. .... 25769782 by 469

A number that divides another without a remainder is said to measure it, and the several numbers that measure another, are called its aliquot parts. Thus 3, 6, 9, 12, 18, are the aliquot parts of 36. As it is frequently necessary to discover numbers which measure others, it may be observed, 1. That every number ending with an even number, that is, with 2, 4, 6, 8, or 0, is measured by 2. 2. Every number ending with 5, or 0, is measured by 5. 3. Every number, whose figures, when added, amount to an even number of 3's or 9's, is measured by 3 or 9 respectively.

In speaking of the contractions and variety in division, we have already seen, that when the divisor does not exceed 12, the whole computation may be performed without setting down any figure except the quotient.

When the divisor is a composite number, we may divide successively by the component parts: thus if 678450 is to be divided by 75, we may either perform the operation by long division, or divide by 5, 5, and 3, because $5 \times 5 \times 3 = 75$.

When there are cyphers annexed to the divisor, cut them off, and cut off also an equal number of figures from the dividend; annex these figures to the remainder.

Example.

Divide 54234564 by 602400

```
6024,00) 542345,64 (90 18564/602400
         54216
         .....18564
```

To divide by 10, 100, 1000, &c. Cut off as many figures on the right hand of the dividend as there are cyphers in the divisor. The figures which remain on the left hand compose the quotient, and those cut off compose the remainder.

Example.

Divide 594256 by 1000.

1,000) 594,356

Ans. $594\frac{596}{1000}$.

When the divisor consists of several figures, we may try them separately, by enquiring how often the first figure of the divisor is contained in the first figure of the dividend, and the considering whether the second and following figures of the divisor be contained as often in the corresponding ones of the dividend, with the remainder, if any, prefixed. If not, we must begin again, and make trial of a lower number.

We may form a table of the products of the divisor multiplied by the nine digits, in order to discover more readily how often it is contained in each part of the dividend. This is always useful when the dividend is very long, or when it is required to divide frequently by the same divisor.

Exumple.

Divide 689543271 by 37.

```
37 × 2 =  74     37)689543271(18636304
     3 = 111        37
     4 = 148        319
     5 = 185        296
     6 = 222        ·235
     7 = 259         222
     8 = 296         ·134
     9 = 333          111
                      ·233
                       222
                        112
                        111
                         171
                         148
                          ·23
```

As multiplication supplies the place of frequent additions, and division of frequent subtraction, they are only repetitions and contractions of the simple rules, and when compared together, their tendency is exactly opposite. As numbers increased by addition are diminished and brought back to their orginal quantity by subtraction, in the same manner numbers compounded by multiplication are reduced by division to the parts from which they are compounded. The multiplier shows how many additions are necessary to produce the number, and the quotient shows how many subtractions are necessary to exhaust it. Hence it follows, that the product divided by the multiplicand will give the multiplier; and because either factor may be assumed for the multiplicand, therefore the product divided by either factor gives the other. It also follows, that the dividend is equal to the product of the divisor and quotient multiplied together, and of course these operations mutually prove each other.

To prove Multiplication. Divide the product by either factor: if the operation be right, the quotient is the other factor, and there is no remainder.

To prove Division. Multiply the divisor and quotient together; to the product add the remainder, if any; and if the operation be right it makes up the dividend.—We proceed to

COMPOUND DIVISION,

For the operation of which the rule is: when the dividend only consists of different denominations, divide the higher denomination, and reduce the remainder to the next

lower taking in the given number of that denomination, and continue the division. When the divisor is not greater than 12, we proceed as before in short divison.

Examples.

	£.	s.	d.		£.	s.	d.
5)	84 ..	3 ..	9	11)	976 ..	13 ..	$7\frac{3}{4}$
Ans.	16 ..	16 ..	9	Ans.	88 ..	15 ..	$9\frac{1}{4}$—8

	lb.	oz.	dwts.		cwt.	qr.	lb.	oz.
8)	994 ..	4 ..	8	12)	45 ..	2 ..	18 ..	8
	124 ..	3 ..	11		3 ..	3 ..	6 ..	3 ..5—4

When the divisor is greater than 12, the operation is performed by long division.

Example.

£. s. d.
Divide 8467 .. 16 .. 8 by 659.

£. s. d.
659) 8467 .. 16 .. 8 (12
659
1877
1318
. 559
20
659) 11196 (16
659
4606
3954
. 652
12
659) 7832 (11
7249
583
4
659) 2332 ($\frac{3}{4}$
1977
. 353

Ans. 12 .. 16 .. $11\frac{3}{4}\,\frac{353}{659}$.

In connection with the rule of Division, we may notice another kind of Reduction, so called, though improperly, as by it is meant to bring smaller denominations into larger; as pence into pounds, or drams into hundred weights, &c.; for which the rule is: divide by the parts of each denomination from that given to the highest sought: the remainders, if any, will be of the same name as the quantity from which they were reduced.

Examples.

1. In 415684 farthings how many pounds sterling.

4) 415684
12) 103921
2,0) 866,0 - 1
Ans. £433 .. 0 .. 1

2. How many pounds troy are there in 67890 dwts.

2,0) 6789,0
12) 3394 · 10
282 .. 10 .. 10.

lb. oz. dwts.
Ans. 282 .. 10 .. 10.

Before we conclude this article we may observe, that in computations which require several steps, it is often immaterial what course we follow. Some methods may be preferable to others, in point of ease and brevity; but they all lead to the same conclusion. In addition, or subtraction, we may take the articles in any order. When several numbers are to be multiplied together, we may take the factors in any order, or we may arrange them into several classes; find the product of each class, and them multiply the products together. When a number is to be divided by several others, we may take the divisors in any order, or we may multiply them into one another, and divide by the product; or we may multiply them into several parcels, and divide by the products successively. Finally, when multiplification and division are both required, we may begin with either; and when both are repeatedly necessary, we may collect the multipliers into one product, and the divisors into another; or we may collect them into parcels, or use them singly; and that in any order. To begin with multiplication is generally the better mode, as this order preserves the account as clear as possible from fractions.

We have hitherto given the most ready and direct method of proving the foregoing examples, but there is another which is very generally used, called "casting out the 9's," which depends on this principle: That if any number be divided by 9, the remainder is equal to the remainder obtained, when that sum is divided by 9. For instance, if 87654 be divided by 9, there is a remainder of 3; and if 8, 7, 6, 5, 4, be added together, and the sum 30 be divided by 9, there will be likewise a remainder of 3.

To cast out the 9's of any number, add the figures, and when the sum is equal to or more than 9, pass by the 9, and proceed with the remainder: thus in casting out the 9's of 56774 we say 5 and 7 are 12, 3 above 9; 3 and 7 are 10, 1 above 9, 1 and 7 are 8; 8 and 4 are 12, 3 above 9; the last remainder is to be put down, and then proceed to the other lines according to the following rules.

To prove Addition. Cast out the 9's of the several articles, carrying the results to the following articles, and cast them out of the sum total; if the operations be correct, the two remainders, if any, will agree.

$$\begin{array}{lr} \textit{Example.} & 845 \\ & 346 \\ & 784 \\ \hline \text{Sum} & 1975 \end{array}$$

Here, in casting out the 9's of the three lines to be added, I find a remainder of 4; there is also a remainder of 4 upon casting out the 9's of the sum.

To prove Subtraction. Cast the 9's out of the minuend; then cast them out of the subtrahend and remainder together, and if the same result is obtained in both cases, the operation may be regarded as accurate.

$$\begin{array}{lr} \textit{Example.} & 59876 \\ & 34959 \\ \hline & 24917 \end{array}$$

In casting out the 9's of the upper row, I find the remainder 8, the same is found in casting out the 9's of the two lower lines.

To prove Multiplication. Cast the 9's out of the multiplicand, and put the remainder on one side of a cross, then do the same with the multiplier, and put the remainder on the other side of the cross; multiply these remainders together, and cast the 9's out of the product, the remainder place at the top of the cross; cast the 9's out of the product, and the remainder place at the bottom of the cross, which, if the operation be correct, will be the same as that at the top.

$$\begin{array}{lr} \textit{Example.} & 5943 \\ & 26 \\ \hline & 35658 \\ & 11886 \\ \hline & 154518 \end{array} \qquad \begin{array}{ccc} & 6 & \\ 3 & \times & 8 \\ & 6 & \end{array}$$

To prove Division. Cast the 9's out of the divisor, and also out of the quotient, the remainder of the former place on the side of the cross; that of the latter on the other: multiply them together, and take in the remainder, if any, cast out the 9's, and the remainder put at the top of the cross; this, if the operation be correct, will agree with remainder of the dividend obtained from the dividend after the 9's are cast out.

$$\begin{array}{lr} \textit{Ex.}\ 264) & 87655\ (332 \\ & 792 \\ \hline & .\ 845 \\ & 792 \\ \hline & .\ 535 \\ & 528 \\ \hline & ..\ 7 \end{array} \qquad \begin{array}{ccc} & 4 & \\ 3 & \times & 8 \\ & 4 & \end{array}$$

This method of proving sums lies under disadvantages. 1. If an error of 9, or any of its multiples be committed, the results will nevertheless agree, and so the error will remain undiscovered. This will be the case, when a figure is placed or reckoned in a wrong column, which is a frequent cause of mistake. 2. When it is known that an error has been committed, it is not pointed out where the error lies, and of course not easily corrected.

Having given a full account of the fundamental rules of Arithmetic, we shall refer our readers to the several articles in alphabetical order, for rules depending on the four already treated on. See ALLIGATION, ANNUITIES, EXCHANGE, INTEREST, &c. &c.

ARITHMETICAL *complement of a logarithm*, the sum or number which a logarithm wants of 10,000000: thus the arithmetical complement of the logarithm 8.154032 is 1.845968.

ARM, a part of the human body, terminating at one end in the shoulder, and at the other in the hand. See ANATOMY.

ARMADA, a Spanish term, signifying a fleet of men of war; it is more particularly applied to the ships by which an attempt was made by Philip II. of Spain to invade England, in the reign of Queen Elizabeth, A. D. 1588. This expedition was excited as well by the injuries which the king had sustained from the English arms, as with a view of transmitting his name to posterity, as the defender of the true faith. In the preceding year, a whole fleet of transports was destroyed at Cadiz by Drake, who ravaged the Spanish coast. Cavendish, another sea commander, committed about the same time, great depredations on the Spaniards in the South-Sea, taking 19 vessels richly laden, with which he entered, in triumph, the river

Thames. On these, and other accounts not less mortifying to the pride of Spain, Philip looked for speedy and ample revenge, by the overthrow of the power and credit of Elizabeth, who was every where regarded, as the protector and bulwark of the Protestant religion. These preparations were conducted with secrecy, but with all the vigour of which he was capable. His ministers, admirals, and generals, were employed in the business; and measures were taken, not only in Spain, but in the ports of Sicily, Naples, and Portugal, for fitting out a most tremendous fleet. In Flanders also there were considerable military preparations; and an army of 14,000 men was assembled in the Netherlands, which was kept in readiness to embark, in flat-bottomed vessels constructed for the occasion. To the most renowned nobility, and princes of Italy and Spain, who were ambitious of being enrolled among the conquerors of England, were added many hundreds of English desperadoes, under the conduct of a man who had been banished for selling a Dutch fortress to Spain.

It was hoped that England would not understand till it was too late, that these efforts were directed against her peace and existence as a nation; but the queen was never without secret intelligence of whatever was carrying on in the different parts of the Continent. The spies employed on this, and on every other occasion during her reign, were priests, it being a favourite maxim with her minister, Walsingham, that an active but vicious priest was the best spy in the world.

Elevated with the prospect of certain success, the Spaniards denominated their navy collected for this purpose, "The Invincible Armada." The forces of England seemed to be unequal to the contest, nevertheless Elizabeth scorned to fear; her mind was in every respect adequate to the greatness of the cause. At that period the number of sailors in this country amounted to 14,000, and the navy to only 28 sail, many of which were small in size, and of no great force. The seamen indeed were very superior to those of the enemy with whom they had to contend, which compensated in some measure for the inferiority of the size and force of their vessels. The attachment to their religion and liberties roused the exertions of the English: London supplied 30 ships and 10,000 men, and other places imitated the example. The nobility and gentry, among whom were several Roman Catholics of distinction, united to oppose this conspiracy; they hired, armed, and manned upwards of 40 ships at their own private charge, and the money which the queen demanded by way of loans, was cheerfully and readily granted. The command of the navy was entrusted to Lord Howard of Effingham; the principal fleet was stationed at Plymouth, and a smaller squadron of 40 vessels, commanded by Lord Seymour, lay off Dunkirk. An army of 20,000 men was disposed in different bodies along the coast, and a like number with 1000 horse, under the command of the Earl of Leicester, was stationed at Tilbury, in order to defend the capital. The main army of nearly 40,000 men, were placed under the command of Lord Hunsdon, ready to defend the queen's person, or to march wherever the enemy should appear. The King of Scotland avowed his adherence to Elizabeth, and his readiness to march his whole force, if necessary, to her aid. From Denmark and the Hanse-towns, she likewise received some help. The Protestants in general throughout Europe were anxious for the success of England. On the 29th of May, the Spanish fleet set sail from Lisbon, but on the 30th it was dispersed by a violent storm. As soon however as it could be refitted, it made towards the English coast, consisting of 130 vessels. These preparations had been delayed a whole year, by a circumstance mentioned by Bishop Burnet, and which is referred to in the "Acta Regia" as one of the most curious passages in the English history. "When it seemed," says the historian, "impossible to divert the present execution of so great a design, and there was no strength ready to resist it, a merchant of London effected it by this means. Being very well acquainted with the revenue and expence of Spain, and all that they could do, and knowing that their funds were so swallowed up, that it was impossible for them to victual and fit out their fleet, but by their credit on the bank of Genoa, he undertook to write to all the places of trade, and to get such remittances made on that bank, that he might have so much of the money in his own hands, that there should be none current there equal to the great occasion of victualling the Spanish fleet. He reckoned the keeping of such a treasure dead in his hands till the season of victualling was over, would be a loss of 40,000 *l*. He managed the matter with such secrecy and success, that the fleet could not be set out that

year; at so small a price, and with so skilful a management, says the bishop, was the nation saved at that time." On the 19th of July the famous armada arrived in the Channel, disposing itself in the form of a crescent, and stretching to the distance of seven miles from the extremity of one division to that of the other. As it proceeded up the Channel, Effingham with the English fleet, gave orders to avoid a close fight, but to skirmish with the larger ships of the Spanish fleet, which it continued to do for six days. The armada, having reached Calais, cast anchor, and waited the arrival of the Prince of Parma, who delayed leaving the Flemish ports, until he was assured that the Spaniards were masters of the sea. While the Spanish fleet lay confusedly in this position, the English Admiral by a successful stratagem dispatched several of his smaller ships filled with combustibles into the midst of the enemy, and thus alarmed them to such a degree, that they immediately cut their cables and betook themselves to flight in the greatest disorder and precipitation. The English fleet pursued them and took several ships. A violent tempest then assailed the armada after it had passed the Orkneys, and most of the vessels that had escaped from the battle, were driven on the western isles of Scotland, or on the coast of Ireland, where they were miserably wrecked. Such was the termination of this desperate attempt against the liberties of our country; the foregoing account of which, in a scientific point of view, exhibits the state of naval tactics at that period of our history, and various other topics, interesting to the English reader.

ARMILLARY *sphere*, an artificial sphere, composed of a number of circles, representing the several circles of the mundane sphere, put together in their natural order, to ease and assist the imagination, in conceiving the constitution of the heavens, and the motions of the celestial bodies.

The armillary sphere constructed about 30 years since by Dr. Long, of Cambridge, is 18 feet in diameter, and will conveniently contain 30 persons, who may sit within it, to view, as from a centre, the representation of the celestial sphere. That part of the sphere which to the inhabitants of these kingdoms never rises above the horizon, is cut off, and the whole is so well contrived and adapted, that it turns round with very little labour.

ARMINIANS, in church-history, a sect of christians, which arose in Holland, by a separation from the Calvinists. They are great assertors of free-will. They speak very ambiguously of the prescience of God. They look on the doctrine of the Trinity as a point not necessary to salvation; and many of them hold there is no precept in scripture, by which we are enjoined to adore the Holy Ghost; and that Jesus is not equal to God the Father.

They take their name from Arminius, a disciple of Beza, whose tenets may be thus enumerated: 1. That God has not fixed the future state of mankind by an absolute unconditional decree; but determined from all eternity to bestow salvation on those whom he foresaw would persevere to the end in their faith in Christ, and to inflict punishment on those who should continue in their unbelief, and resist to the end his divine assistance. 2. That Jesus Christ, by his death and sufferings, made an atonement for the sins of mankind in general, and for every individual in particular; that however none but those who believe in him can be partakers of this divine benefit. 3. That mankind are not totally depraved, and that depravity does not come upon them by virtue of Adam's being their public head, but that mortality and natural evil only are the direct consequences of his sin to posterity. 4. That there is no such a thing as irresistible grace in the conversion of sinners: and 5. That those who are united to Christ by faith, may fall from their faith, and finally forfeit their state of grace. Dr. Whitby, an eminent divine of the Church of England, has written a long defence of this doctrine: to this may be noticed, Dr. Taylor's "Key to the Epistle to the Romans." Among the modern writers, Mr. John Wesley, and Mr. Fellowes in his "Religion without Cant," and in his "Christian Philosophy," have ably advocated the cause of Arminianism.

ARMONICA. See HARMONICA.

ARMORY is a branch of the science of heraldry, consisting in the knowledge of coats of arms, as to their blazons and various intendments.

ARMOUR denotes all such habiliments as serve to defend the body from wounds, especially of darts, a sword, a lance, &c. A complete suit of armour formerly consisted of a helmet, a shield, a cuirasse, a coat of mail, a gauntlet, &c. all now laid aside.

ARMS, in general, all kinds of weapons, whether used for offence or defence.

ARMS *and Ammunition*, no merchant

vessel is allowed to carry more than two carriage guns of 4 pounds calibre, nor more than in the proportion of two musquets for every ten men, except ships of marc, or vessels employed in the service of the victualling, ordnance, customs, excise, or post-office, without being regularly licensed for that purpose.

ARMS, or ARMORIES, in heraldry, marks of honour borne upon shields, banners, and coats, in order to distinguish states, families, and persons.

At this time, arms follow the nature of titles, which being made hereditary, they are also become so, being the several marks to distinguish families, as names serve to distinguish individuals. They are the gift of kings and princes, through the ministry of their kings and heralds of arms, who ought to be knowing and judicious, to give the proper arms to all persons.

ARMY, a large body of soldiers, consisting of horse and foot, completely armed, and provided with artillery, ammunition, provisions, &c. under the command of one general, having lieutenant-generals, major-generals, brigadiers, and other officers under him. An army is composed of squadrons and battalions, and is usually divided into three corps, and formed into three lines; the first line is called the van-guard, the second the main body, and the third the rear-guard, or body of reserve. The middle of each line is possessed by the foot, the cavalry form the right and left wing of each line; and sometimes they place squadrons of horse in the intervals between the battalions. When the army is drawn up in order of battle, the horse are placed at five feet distance from each other, and the foot at three. In each line the battalions are distant from each other one hundred and eighty feet, which is nearly equal to the extent of their front; and the same holds of the squadrons, which are about three hundred feet distant, the extent of their own front. These intervals are left for the squadrons and battalions of the second line to range themselves against the intervals of the first, that both may more readily march through those spaces to the enemy: the first line is usually three hundred feet distant from the second, and the second from the third, that there may be sufficient room to rally, when the squadrons and battalions are broken.

Our armies anciently were a sort of militia, composed chiefly of the vassals and tenants of the lords. When each company had served the number of days or months enjoined by their tenure, or the customs of the fees they held, they returned home. Armies are distinguished by the appellations of a covering army, designed to protect the different passes which lead to a principal object of defence: a blockading army, which is provided with heavy ordinance and other warlike means, and is employed to invest a town for the direct and immediate purpose of reducing it by assault or famine: an army of observation, so called because by its advanced positions and desultory movements, it is constantly employed in watching an army: an army of reserve, which is a general depôt of effective service;—in cases of emergency, the whole or detached parts of an army of reserve are employed to recover a lost day, or to secure a victory: and a flying army, which is mostly a strong body of horse and foot, always in motion, both to cover with its own garrison, and to keep the enemy in continual alarm.

ARNICA, in botany, a genus of plants of the Syngenesia Superflua class and order. Essen. char. receptacle naked; down simple; calyx equal; florets of the margin generally with five filaments destitute of antheræ. There are 24 species.

ARNOPOGON, a genus of the Syngenesia Æqualis class and order. Receptacle naked; down feathery, on a pedicel; calyx one-leafed, eight-parted, turbinate. There are four species.

AROMA, is that part of odorous bodies which affects the organs of smell, and is supposed by some to be a peculiar principle.

ARRAC, a spirituous liquor imported from the East Indies, and obtained by distillation from rice or sugar, fermented with the juice of cocoa nuts.

ARRAGONITE, a mineral first found in Arragon, imbedded in gypsum; afterwards in the Pyrenees, and at Salzburgh. Colour greenish and pearl-grey; in the middle often violet and green. Always crystallized in regular six-sided prisms. Fracture between imperfect, foliated, and fibrous. Colour arranged in the direction of the fibres; the longitudinal fibres green; the transverse violet-blue, brittle; specific gravity 2.94. It effervesces with acids, and from its resemblance to appatite, Werner is of opinion that it may contain a small portion of phosphoric acid; but neither Klaproth nor Thenard have been able to detect in it any thing but lime and carbonic acid. It is said to have been found in France, and in the

Pyrenean mountains. Its specific gravity makes it intermediate between calc-spar, and appatite.

ARRAIGNMENT, in law, the arraigning or setting a thing in order, as a person is said to arraign a writ of novel disseisin, who prepares and fits it for trial. It is most properly used to call a person to answer in form of law upon an indictment, &c. at the suit of the king.

The arraignment is to take care that the prisoner appears to be tried, and hold up his hand at the bar for the certainty of the person, and plead a sufficient plea to the indictment. The prisoner is to hold up his hand only in treason and felony; but this is only a ceremony: if he owns that he is the person, it is sufficient without it; and then, upon his arraignment, his fetters are to be taken off. A prisoner under indictment of the highest crime must be brought to the bar without irons, shackles, or bonds. This is the law; but to the disgrace of our courts it is almost wholly disregarded, and prisoners are generally tried in their irons.

ARRANGEMENT, in music, is that extension, selection, and disposal of the movements and parts of a composition, which fit and accommodate it to the powers of some instrument or instruments for which it was not originally designed by the composer.

ARREARS, the remainder of a sum due, or money remaining in the hands of, an accountant. It signifies also, more generally, the money that is due for rent unpaid for land or houses; likewise what remains unpaid of pensions, taxes, or any other money payable annually, or at any fixed term.

ARREST, in civil cases, is a legal restraint of a person charged with some debt to an individual; and, in criminal cases, for some crime against the state; and it is executed in pursuance of the command of some court of record, or officer of justice. Certain persons are privileged from arrests, as members of parliament, peeresses by birth, marriage, &c., members of convocation actually attending them, ambassadors, domestic servants of ambassadors, king's servants, marshals, or wardens of the fleet, clerks, attornies, or other persons attending the courts of justice, clergymen performing divine service, suitors, witnesses subpœnaed, and other persons necessarily attending any court of record upon business, bankrupts coming to surrender, within 42 days after their surrender, witnesses properly summoned before commissioners of bankruptcy, or other commissioners of great seal; sailors and volunteer soldiers, unless the debt be 20*l.*, officers of court, only where they are sued in their rights, but not if as executors or administrators, nor in joint actions. No writ, process, warrant, &c. (except for treason, felony, or for breach of the peace), shall be served on Sunday; but a person arrested the day before, may be retaken on the Sunday. No person can be arrested out of a superior court, unless the cause of action be 10*l.* and upwards; an arrest must be by corporal seizing, or touching the defendant. An officer cannot justify breaking open an outward door or window to execute process, unless a stranger who is not of the family, upon a pursuit, take refuge in the house of another. The chamber of a lodger is not to be considered as his outer door. No officer shall carry his prisoner to any tavern without his consent, nor to gaol within 24 hours after his arrest, unless he refuse to go to some safe house. In criminal cases, the causes of suspicion which justify the arrest of a person for felony are, the common fame of the country, the living a vagrant, idle, disorderly life, without any visible means to support it; the being in company with a known offender at the time of the offence; the being found in circumstances which induce a strong presumption of guilt; behaviour betraying a consciousness of guilt; and the being pursued by hue and cry. But none of these causes will justify the arresting a man for the suspicion of crimes, unless a crime has been actually committed.

ARREST *of judgment:* to move in arrest of judgment, is to shew cause why judgment should not be stayed, notwithstanding a verdict given. The causes of arrest of judgment are, want of notice of trial; where the plaintiff before trial treats the jury; the record differs from the deed pleaded; for material defect in pleading; where persons are misnamed; more is given and found by the verdict, than laid in the declaration; or, the declaration doth not lay the thing with certainty, &c.

ARRONDEE, in heraldry, a cross, the arms of which are composed of sections of a circle, not opposite to each other, so as to make the arms bulge out thicker in one part than another: but the sections of each arm lying the same way, so that the arm is every where of an equal thickness, and all of them terminating at the edge of the escutcheon like the plain cross.

ARSENAL, in military affairs, in a large and well fortified town, is a spacious build-

ing, in which are deposited all kinds of arms, and other warlike implements, such as cannon, mortars, howitzers, small arms, and every other warlike kind of engines and instruments of death.

ARSENIATES, in chemistry, a genus of salts, formed from arsenic acid and some particular base; thus we have the arseniates of potash, the arseniates of soda, lime, &c. They are distinguished by the following property: when heated with charcoal powder, they are decomposed, and the arsenic sublimes. These salts have not hitherto been applied to any useful purpose, and have at present been but superficially examined.

ARSENIC, in mineralogy, one of the metals that are brittle and easily fused. The word occurs first in the works of Dioscorides, and other authors, who wrote about the beginning of the Christian æra: it denotes in their works the same substance which Aristotle had called σανδαραχη, which is a reddish-coloured mineral, composed of arsenic and sulphur, used by the ancients in painting and as a medicine.

Arsenic, as it is to be found in the shops, occurs in the state of a white oxide, from which the metal may be obtained by the following process. Mix two parts of the white oxide with one part of black flux (prepared by detonating, in a crucible, one part of nitre with two of crystals of tartar), and put the mixture into a crucible. Invert over this another crucible; lute the two together, by a mixture of clay and sand, and apply a red heat to the lower one. The arsenic will be reduced, and will be found lining the inside of the upper crucible, in a state of metallic brilliancy. Arsenic is oxidized by mere exposure to the atmosphere. It soon becomes tarnished, loses its metallic lustre, and is changed into a blackish oxide. It is readily fusible, and is volatilized at 356°. In close vessels it may be collected unchanged; but when thrown on a red hot iron, it burns with a blue flame and a white smoke, and a strong smell of garlic is perceived. All the mineral acids act on arsenic; but not considerably, unless they are heated. In the oxigenized muriatic acid gas, however, arsenic burns vehemently. A mixture of oxy-muriate of potash and arsenic furnishes a detonating compound, which takes fire with the rapidity of lightning. The salt and metal, first separately powdered, may be mixed by the gentlest possible triture, or rather by stirring them together on paper with a knife point. If two long trains be laid on a table, the one of gunpowder, and the other of this mixture, and they be in contact with each other at one end, so that they may be fired at once, the arsenical mixture burns with the rapidity of lightning, while the other burns with comparatively extreme slowness. Arsenic has the property of giving a white stain to copper. Let a small bit of metallic arsenic be put between two small plates of copper; bind these closely together with iron wire, and heat them, barely to redness, in the fire. The inside of the copper plates will be stained white. The white oxide of arsenic has the following properties: 1. It has an acrid taste, and is highly poisonous. 2. It is soluble in water, which, at the ordinary temperature, take up 1-80th. According to La Grange, it is soluble in 1-24th of cold water, or 1-15th of hot. 3. Oxide of arsenic combines with the pure alkalies to saturation; and hence it fulfils one of the principal functions of an acid. It has therefore been called arsenous acid, and its compounds arsenites. They may be formed by simply boiling the acid with a pure alkaline solution. 4. The arsenous acid, by distillation with sulphur, affords either a yellow substance, called orpiment, or a red one, termed realgar. Both these compounds are sulphuretted oxides of arsenic, varying in the proportion of their components. The hydro-sulphurets also throw down a yellow precipitate from solutions of arsenous acid. Sulphate of copper, mixed with arsenite of potash, gives a beautiful precipitate, called, from its discoverer, Scheele's green. 5. By repeated distillation with nitric acid, arsenous acid is changed into arsenic acid. The same change is effected also by exposure to the vapour of oxigenized muriatic acid, and the expulsion, by heat, of the common muriatic acid. By both these processes, a white concrete substance is obtained, termed arsenic acid. The arsenic acid has a sour, and at the same time, a metallic taste. It reddens vegetable blues, attracts humidity from the atmosphere, and effervesces strongly with solutions of alkaline carbonates. With alkalies, earths, and oxides, it constitutes a class of salts, called arsenates. The arsenate of potash may be obtained in a more simple manner, by detonating, in a crucible, a mixture of nitrate of potash with arsenous acid. When tin is dissolved in arsenic acid, an inflammable gas is disengaged, as was observed by Scheele, consisting of hydrogen gas, holding arsenic in solution. It may be obtained also by adding powdered metallic arsenic to

a mixture of diluted sulphuric acid and zinc filings.

ARSENIC *acid.* }
ARSENIOUS *acid.* } See ARSENIC.

ARSENITES, a name given by Fourcroy to the combinations formed between white oxide of arsenic, or arsenious acid, as he calls it, and the alkalies and earths. They were formerly termed livers of arsenic, from some fancied resemblance which was traced between arsenic and sulphur. The alkaline arsenites may be prepared by dissolving the white oxide in alkaline solutions. They do not crystallize: heat decomposes them by subliming the oxide, and almost all the acids precipitate the arsenic in the form of a white powder. The earthy arsenites, as far as they have been examined, are insoluble powders, which is the reason why white oxide of arsenic occasions a precipitate when dropped into lime, barytes, or strontian water.

ARSON, is house burning, and burning the house of another is felony. Cr. Law, Case 143. It must be maliciously and voluntarily, and an actual burning; not putting fire only into a house, or any part of it, without burning; but if part of the house be burnt, or if the fire do burn, and then go out of itself, it is felony. 2 Inst. 188. But it is not felony to burn a house (unless done with a fraudulent intent) of which the offender is in possession by virtue of a written agreement, for a lease for three years. Cr. Law 143. If any servant through carelessness shall fire any house or outhouse, and be thereof convicted on the oath of one witness, before two justices, he shall forfeit one hundred pounds to the churchwardens of the parish where the fire shall happen, to be by them distributed to the sufferers; and, on non-payment thereof, immediately on demand, the said justice shall commit him to some house of correction for 18 months, to be there kept to hard labour.

The punishment of arson was death by our ancient Saxon laws. And in the reign of Edward I. this sentence was executed by a kind of "lex talionis," for the incendiaries were burnt to death, as they were also by the Gothic constitutions. The statute 8 Hen.VI. c. 6, made the wilful burning of houses, under some special circumstances therein mentioned, amount to the crime of high treason. But it was again reduced to felony, by the general acts of Edw. VI. and Queen Mary; and now the punishment of all capital felonies is uniform, namely, by hanging. The offence of arson was denied the benefit of clergy by 31 Hen. VIII. c. 1; but that statute was repealed by 1 Edw.VI. c. 12.; and arson was afterwards held to be ousted of clergy, with respect to the principal offender, only by inference and deduction from the statute 4 and 5 P. and M. c. 4., which expressly denied it to the accessary before the fact: though even it is expressly denied to the principal in all cases within the statute 9 Geo. I. c. 22.

ART *and Part*, in the law of Scotland, is applied to an accomplice.

The facts inferring art and part need not be particularly laid in the libel or indictment, for these general words, as terms of stated signification, are sufficient. Yet these facts may be set forth, and it is proper so to do, if the prosecutor chuses to confide in the court rather than in the jury.

Also in the criminal letters, the persons of the accomplices must be described by proper names and designations.

One may be art and part, 1. By giving counsel to perpetrate, without distinction, whether the crime would have been committed without such counsel or not; this being what can never be perfectly known. But it is to be observed, that in the more atrocious crimes, he that gives counsel is equally punished as he that commits them; but in the less atrocious, less severely. And sometimes reasons of mitigation are taken from the age, the manner of advising, &c. 2. By aid and assistance, and that either previous, or concomitant, or subsequent, to the commission of the crime. The first rarely comes up to art and part, unless very particularly qualified; the second commonly does, and it is easily known, if it does not; the third never, and hardly deserves the name, unless it be in providing for the criminal's escape. But any of the three make art and part, if the perpetration was premeditated. 3. By a clear and explicit mandate to commit the crime, or to do somewhat unlawful in itself, which with great probability might produce it, if executed by the hand of the mandatory, and not that of another.

ARTEDIA, a genus of the Pentandria Digynia class of plants, the general umbel of which is multiple, plane, and patent; the partial umbel is small, but similar; the general involucrum is composed of about ten leaves; they are of an oblong oval figure, nearly of the length of the umbel, and have three spines or setæ at their extremities: the partial involucrum is composed of two or three leaves, and turns outward: the ge-

neral corolla is difform, and radiated; the single flowers of the disk are all males, they consist each of five erect inflexo-cordate petals; the single flowers of the radius are all hermaphrodites, they consist of the same number of petals, but in these the exterior one is larger than the rest, and is divided into two parts; the fruit is roundish, compressed, and divisible into two parts; the seeds are two, oblong and elegantly ridged at the edges, with round squammæ.

ARTEL, in commerce, a name given to a commercial association, consisting of a certain number of labourers, who voluntarily become responsible as a body, for the honesty of each individual. The separate earnings of each man are put into the common stock; a monthly allowance is made for his support: and at the end of the year the surplus is equally divided. The number varies in different associations from 50 to 100; and it is considered so beneficial to belong to one of these societies, that 500, and even 1000 roubles are paid for admission. These societies are not bound by any law of the empire, or even written agreement; nor does the merchant restrain them under any legal obligation; yet there has been no instance of their objecting to any just claim, or of protecting an individual whose conduct had brought a demand on the society. Hence arises the denomination of Artilschisks, who are persons employed by the Russian merchants of St. Petersburgh, to collect payment on bills, to receive and pay money, and also to superintend the loading and unloading of the different cargoes. These Russians are mostly natives of Archangel, and the adjacent governments, of the lowest class; they are frequently slaves, generally of the crown; and yet the merchant has no reason to distrust their fidelity, partly from the nature of their association, and partly from the natural reluctance of the Russian to betray the confidence that is reposed in him.

ARTEMISIA, in botany, a genus of plants of the Syngenesia Superflua class and order. Essen. char. receptacle naked or villous; calyx imbricate, with rounded connivent scales; florets of the margin subulate, very entire. This genus is separated into four divisions: A. shrubs or undershrubs; of these there are 14 species, the most remarkable is A. abrotanum, southernwood, which seldom grows more than three or four feet high. In some gardens, where the soil is well adapted to its nature, it has been seen much higher; but in mountainous situations, it is low and slender, with the stems lying on the ground. It is bitter and aromatic, with a very strong smell. It is rarely used in medicine but as an ingredient in discutient and antiseptic fomentations. The branches dye wool yellow. B. herbaceous, with the stem quite simple; flowers racemed: of these there are ten species. C. herbaceous; stem more or less branched; flowers panicled; leaves compound: there are about forty species of this division, among which is 1. A. absinthium, common wormwood, a plant well known in this country. It is found wild in almost every part of Europe, in rocky places, by the road-sides, among rubbish, about farm-yards; flowering from July to October. The leaves and flowers are very bitter; the roots are warm and aromatic. A considerable quantity of oil rises from it in distillation, which is used both externally and internally to destroy worms. The leaves put into sour beer destroy the acescency. They resist putrefaction, and are therefore a principal ingredient in antiseptic fomentations. An infusion of them is a good stomachic, and with the addition of a fixed alkali, a powerful diuretic in dropsical cases. The ashes afford a purer alkali than most other vegetables, excepting bean-stalks, broom, and the larger trees. 2. A. vulgaris, mugwort, found wild over the greatest part of Europe, China, Japan, &c. on the borders of fields and ditch-banks, by way-sides, in waste places, and about farm-yards. It is used in some countries as a culinary aromatic. A decoction of it is taken by the common people to cure the ague. The moxa of Japan is prepared from this species. The leaves are collected in June, dried in the shade, and beat in a mortar till they become like tow; this substance is then rubbed between the hands, till the harder fibres and membranes are separated, and there remains nothing but a very fine cotton. The Japanese use it for tinder, and twice in a year men and women, young and old, rich and poor, are indiscriminately burnt with the moxa, either to prevent disorders, or to cure the rheumatism. D. more or less shrubby; stem branched; leaves undivided; there are five species, of which one is A. cærulescens, tarragon, a capital addition to sallads, and much used in France.

ARTERY, in anatomy, a conical tube or canal, which conveys the blood from the heart to all parts of the body. See ANATOMY.

ARTICHOKE. See CYNARA.

ARTICLE, in grammar, a particle, in most languages, that serves to express the several cases and genders of nouns, when the languages have not different terminations to denote the different states and circumstances of nouns. See GRAMMAR.

The Latin has no article; but the Greeks have their ο; the eastern languages have their *he emphaticum;* and most of the modern languages have had recourse to articles. The only articles made use of in the English tongue are *a* and *the;* which, prefixed to substantives, determine their general signification to some particular thing. The use of *a* is in a general sense, and may be applied to any particular person or thing, and upon that account is called an indefinite article: but *the*, being a determinate article, is called definite, or demonstrative, as applying the word to one individual. The French have three articles, *le, la*, and *les;* the Italians have their *il, lo*, and *la;* and the Germans their *der, das*, and *dat.*

ARTICLES *of war*, are certain regulations for the better government of the army in the kingdoms of Great Britain and Ireland, and foreign parts dependant upon Great Britain. They may be altered and enlarged at the pleasure of the king; and in certain cases they extend to civilians—as when by proclamation any place shall be put under martial law, or when people follow a camp or army for the sale of merchandize, or serve in any menial capacity. It is ordained that the articles of war shall be read in the circle of each regiment belonging to the British army every month, or oftener, if the commanding officer think proper. A soldier is not liable to be tried by a military tribunal, unless it can be proved that the articles of war have been duly read to him.

ARTICULATE *sounds* are such sounds as express the letters, syllables, or words of any alphabet or language; such are formed by the human voice, and by some few birds, as parrots, &c. Other brutes cannot articulate the sounds of their voice.

ARTICULATED, something furnished with, or consisting of joints.

ARTICULATION, in anatomy, denotes the juncture of two bones, intended for motion.

ARTICULATION, in music, applies equally to vocal and to instrumental performances, to words, and to notes; and it includes that distinctness and accuracy of expression, which gives every syllable and sound with truth and perspicuity, and forms the very foundations of pathos and grace.

ARTIFICERS, those who work with the hands, and manufacture any kind of commodity in iron, brass, wood, &c. Artificers are the same with what we otherwise call handicrafts and mechanics; such are smiths, carpenters, taylors, shoemakers, weavers, and the like. The Roman artificers had their peculiar temples, where they assembled, and chose their patron, to defend their causes: they were exempted from all personal services. Taruntinus Paternus reckons thirty-two species of artificers, and Constantine thirty-five, who enjoyed this privilege. The artificers were incorporated into divers colleges or companies, each of which had their tutelar gods, to whom they offered their worship; and several of these, when they quitted their profession, hung up their tools, a votive offering to their gods. Artificers were held a degree below merchants and argentarii, or money-changers, and their employment more sordid. Some deny that, in the earliest ages of the Roman state, artificers were ranked in the number of citizens; others, who assert their citizenship, allow that they were held in contempt, as being unfit for war, and so poor that they could scarce pay any taxes. For which reason they were not entered among the citizens, in the censor's books; the design of the censors being only to see what number of persons were yearly fit to bear arms, and to pay taxes towards the support of the state. It may be added that much of the business of artificers was done by slaves and foreigners, who left little for the Romans to mind but their husbandry and war. By means of the arts, the minds of men are engaged in inventions beneficial to the community; and thus prove the grand preservative against the barbarism and brutality which ever attend on an indolent and inactive stupidity. By the English laws, a stranger, being an artificer in London, &c. shall not keep above two stranger servants; but he may have as many English servants and apprentices as he can get. And as to artificers in wool, iron, steel, brass, or other metal, &c. persons contracting with them to go out of the kingdom into any foreign country are to be imprisoned three months, and fined in a sum not exceeding one hundred pounds. And such as going abroad, and not returning on warning given by our ambassadors, &c. shall be disabled from holding lands by descent or devise, from receiving any legacy, &c. and be deemed aliens. Penalty of 500*l*. and of imprisonment for twelve months, for the first offence; and for the second, of 1000*l*. and of

imprisonment for two years; is also inflicted on persons seducing artificers to go abroad.

A stranger-artificer in London shall not keep more than two stranger servants. 2 Hen. VIII. c. 16. Persons contracting with artificers in wool, iron, steel, brass, or other metal, &c. to go to any foreign country, shall be imprisoned three months. 5 Geo. I. c. 27; and if any person shall contract with, or encourage any artificers employed in printing callicoes, cottons, muslins, or linens of any sort, or in making any tools or utensils for such manufactory, to go out of Great Britain to any port beyond the seas, he shall forfeit 500*l.* and be committed to the common gaol of the county for 12 months, and until such forfeiture shall be paid. 22 Geo. III. c. 60. sect. 12.

ARTILLERY, in the most appropriate application of the word, means the cannon, mortars, howitzers, and other large pieces, for discharging shot and shells by the expansive force of inflamed gunpowder, as used in the land service. In a more enlarged sense the word denotes engines of war of all sorts, ancient and modern, by which darts, stones, bullets, &c. were shot forth in battle. See BALLISTA, CATAPULTA, &c.

Artillery, or cannon and mortars, is generally supposed to have been first used in Europe by the Venetians, in the siege of Claudia Jesse, now called Chioggia, in 1366; and in their wars with the Genoese, 1379. But Edward the Third is known to have used cannon at the battle of Cressy, in 1346, and at the siege of Calais, in 1347. And facts that will be mentioned give reason to suppose that it was partially used in this quarter of the world before that period. A treatise of the famous Roger Bacon, written in 1280, is the first European publication which mentions the composition of gunpowder, and proposes its use in war; the invention is, however, most commonly though unjustly attributed to Bartholdus Schwartz, a German, in 1320. Bacon only proposed the use of the unconfined flame of gunpowder as a mode of annoying an enemy; but Schwartz is supposed to have discovered its application in projecting heavy bodies, from an accidental explosion of some in a common mortar, in which he had mixed its ingredients together, having blown off an heavy stone cover to a considerable distance; and it is imagined that the mortars now used for throwing shells derived their name from their resemblance to those used by chemists, in one of which the above accident occurring had first suggested the use that might be made in war of metallic vessels of a somewhat similar form.

The little which was formerly known of Asiatic history, and the undeserved neglect with which it is still treated, made the above account of the origin of cannon satisfactory hitherto. But to consider the invention of cannon as an European invention, at the present period when we have such authentic documents of their use in China many centuries before they were thought of in this part of the world, would be willfully to sacrifice truth to the childish vanity that leads Europeans too often to arrogate an imaginary superiority in every thing over the inhabitants of the more early civilized states of the eastern hemisphere.

If the testimony of the Chinese themselves is not sufficient on this point, the fact of their famed great wall being furnished with embrasures, fitted in such a manner for cannon as to leave no doubt of their having been in use at the time of its erection, sufficiently proves it. To which an additional argument may be added from their very ancient game of chess, in which pieces have been used from remote antiquity, designating engines of war whose power was derived from gunpowder. Mr. Irwin, in his paper on the Chinese Game of Chess, in the Transactions of the Royal Irish Academy, proves that gunpowder was in common use in China 371 years after Confucius, or 161 years before Christ; and Du Halde has long since given documents to shew that the Chinese wall was in existence 200 years before the commencement of the Christian æra; and consequently for the reason before stated, the use of cannon must have been of at least equal antiquity. And there is a strong probability that the invention was of a much more remote date; as it is not likely that cannon, immediately after the discovery of gunpowder, would have been brought to sufficient perfection for wall service; or that a very new invention would have been alluded to in the nomination of the pieces used in the game of chess, peculiar to China.

It is so far from an impossibility that the same thing may have been invented by different persons in various parts of the world, that no fact is better proved to have frequently occurred; but to invent an important matter, and to bring it into general use, are distinct affairs, and seldom fall to the lot of the same person.

The discovery made by Bacon was most probably not more attended to in an age of ignorance, than new discoveries are at the present enlightened period, when they make such a slow progress towards universal adoption; and that of Schwartz was evidently of the same nature. It is, therefore, much more probable that the use of gunpowder in war was derived ultimately from the Chinese, than that it originated in the cell of an obscure monk, such as Schwartz; or of one, though of more notoriety, yet from the prejudices of the times held in abhorrence for an imputation of sorcery, as Bacon was. The mode in which the use of gunpowder in war might have passed from China to Europe, is the most probable and simple imaginable. Zingis Khan is known to have conquered the five northern provinces of China about the year 1234. In this conquest that he must have learned the use of gunpowder, and have practised it afterwards, would have been manifest from reason alone; as at that time it had been in common use in China upwards of 1400 years, from the facts before stated. But we have also the positive testimony of history to attest this point, for in the Chinese annals of the Moguls by Yuen, as translated by Pere Gaubil, it is particularly stated that the use of cannon and mortars was familiar in the wars and sieges of Zingis against the Chinese, both by them and him, in attack and defence. It is most probable that he used gunpowder in his wars against Mohammed, Sultan of Carisme, whose dominions extended from the Persian Gulph to the borders of India and of Turkistan; all which he added to his empire, destroying many flourishing cities, and laying waste a tract of many hundred miles, extending from the Caspian Sea to the Indus, which was richly adorned with the labours and buildings of mankind; and which has not yet in the least recovered from the effect of his ravages. It is well known that he had a body of Chinese engineers in his army, who of course must have been acquainted with the use of gunpowder; and his rapid successes were probably greatly owing to this circumstance. The conquests of Zingis would thus have spread the knowledge of gunpowder over the western part of Asia, where at the time of the crusades the Europeans would have frequent opportunities of learning it; and accordingly we find that it was just after this time that it was first used by Europeans in war. At no long period after the return of Edward the First to England, who was so famous for his victories in Palestine, we hear of cannon used by the English against the French. The Venetians who used them in their wars to so much greater extent, that the invention has been commonly attributed to them, were of all Europeans the most connected with Asia at that period; therefore those who would be most likely to learn the use of gunpowder from the Asiatics; and these are strong testimonies in favour of the introduction of the invention into Europe in the manner stated, especially as we can trace many arts to Asia, which are well known to have been also learned there by Europeans at the time of the Crusades. Another argument in favour of this opinion is, that the first war in which cannon were much employed in Europe, was one carried on by Asiatics against Europeans, in which they were used exclusively by the Asiatics. It was most remarkable in this war at the siege of Constantinople, and in 1453, in which Mahomet the Second used one of the largest cannon ever made, which threw a stone bullet of 600*lbs*. weight. Some knowledge of the use of gunpowder might also have been introduced into Europe by the successes of Zingis, who extended their conquests over a large portion of Russia, the greatest part of Poland, and subdued all Hungary except three cities, and overran Servia, Bosnia, and Bulgaria; and who must have known its effects in war, when it was used by the armies of their predecessor as before shewn. In addition to the reasons mentioned for the Asiatic origin of the use of gunpowder, it should be noted that the Germans were one of the last nations in Europe who adopted its use; which renders its having been first invented in that country highly improbable.

It was many years after the introduction of cannon in Europe before they attained that form and equipment which fitted them for any extensive use. At the siege of Constantinople, before mentioned, which was 107 years after the battle of Cressy, their form was in the highest degree rude and inconvenient; the object in their use then seemed to be to imitate the effect of the ancient balista, in throwing large masses of stone; the large cannon, before mentioned, that threw a stone of 600*lbs*. weight, was so unwieldy that 60 oxen were employed nearly two months in drawing it about 150 miles from Adrianople; and it could be only charged and discharged seven times each day.

We find that at no very remote period

the chief reliance in war continued to be placed in other implements of battle than those for which gunpowder was necessary. In the reign of Henry the Seventh it appears that cannon were in some degree neglected, as there is said to be no order on record relative to gunpowder or cannon in his reign. In the reign of Elizabeth the effect of the bow and arrow still seems to be preferred in war to that produced by gunpowder, as there were several acts passed by her relative to bows and archery, which shewed them then to be considered as of the utmost importance; and even as late as the reign of Charles the First, two special commissions were granted for enforcing the use of the long bow.

In fact, it is only a few years back since the use of cannon in the field, or artillery properly so called, obtained the predominance it at present holds. The area of the French revolution may be considered that of its complete adoption; which was not a little aided by the invention of the species called flying artillery, which took place shortly afterwards.

By artillery is also understood, the science which the officers of artillery ought to possess. This science teaches the knowledge of the materials and ingredients that enter into the composition and structure of whatever relates to the artillery: the construction, proportion, &c. of the different warlike machines: the arrangement, movement, and management of cannon, in the field, or in sieges, in such a manner, that each of them, according to the length of its tube, and the diameter of its bore, may be situated in the best place for doing execution; and that the whole train, taken together, may assist and support each other with the greatest advantage.

Cannon are chiefly prepared by casting fused metal into moulds made of a fit form, and afterwards boring out the barrels and touch-holes from the solid mass. They were formerly cast with the barrels hollowed out in part, and were afterwards finished by boring; but the method now in use prepares a greater proportion of perfect pieces out of a given number of casts.

Cannon for field service, or artillery, are usually made of copper alloyed with about a tenth of tin; the tin adds hardness and solidity to the composition, which (on account of its lightness, its greater durability, and being less liable to burst; and when that accident occurs not being apt to fly asunder in small pieces, but rather splitting asunder,) is preferred to cast iron. It is possible to make them even lighter of hammered iron than of the above composition; and a very neatly finished piece of this kind is among the stores at the Warren in Woolwich, sent in some years ago by the maker, as a specimen of what might be done in this way. It was judged that its recoil would be too great, on account of its singular lightness, and therefore this sort was not introduced into actual service; but it would be no great difficulty to prepare carriages for them, so as to admit of having a sufficient load of sand or earth added when wanted, which might be thrown away when they were to be moved to any distance; and then their great lightness would fit them admirably for service in mountainous countries. Cannon have also been made of staves of hammered iron, bound together by hoops of the same metal, and a large one of this sort may be seen at the Tower; but we have no account as to their use, durability, or safety.

The form preferred for cannon may be defined that of a right cone, obtruncated at the apex, and from which a small cylinder has been subtracted to form the barrel. The greatest force of the ignited powder being exerted at the breach, a cannon is of course made thickest at that part; its thickness diminishes but little for about a quarter of its length, when it is suddenly reduced in the breadth of its mouldings in that part; it is again reduced abruptly at about half its length, and then continues diminishing very gradually to near the muzzle, where it is again enlarged; it having been found that the shot in departing was apt to exert a greater force against the gun in that place. The two parts of the gun where the thickness is increased are called the reinforces. Some guns have been made in foreign countries, which have no reinforces or increase of thickness at the muzzle; a very beautiful one of this description, of brass, of a large size, now lies in St. James's Park, as a trophy of war, brought from Egypt by the victorious troops commanded by General Lord Hutchinson.

The following Table shews the dimensions of heavy, medium, and light brass guns, in thirty second parts of their respective calibres.

			Heavy.	Medium	Light.
Thickness of metal.	At the breach and commencement of the first reinforce		33	32	22
	End of the first reinforce		26	25	16
	Muzzle astragal		17	16	10
Trunnions.	Diameter		32	30	20
	Length		32	30	24
Cascable.	From the extremity of the base ring to that of the breach mouldings		12	10	9
	From the end of the breech mouldings to the centre of the button.		30	24	24
	Breadth of the ovalo, or quarter round		4	3	3
	Diameter	Of the button	32	26	26
		Of the neck	26	22	20
		Of the last fillet	48	44	36

In heavy and medium brass guns the first and second reinforces are similar frustrums of right cones; and consequently, when produced, their outlines will be parallel to each other, and are distant one-sixteenth part of the calibre. The exterior diameter of the piece is also diminished by that quantity, and its outline is drawn to the muzzle astragal.

In light guns the length of the piece must be divided into 18 equal parts, of which

5 parts are taken for the breech and first reinforce;
4 parts for the second reinforce;
9 ...... for the chase;
$2\frac{1}{2}$ .. ... for the length of the muzzle;
$\frac{1}{2}$ part for the diameter of the neck.

The axis of the trunnions are 8 parts from the breech, and half a calibre below the axis of the piece. The position of the trunnions of heavy and medium brass guns is at $\frac{3}{7}$ths of the length of the piece, from the extremity of the breech, and half a calibre below the axis of the piece, reckoning to their centres. The diameter of the trunnions are each one calibre, and their length the same, allowing for the projection of the second reinforce ring; their faces are parallel to the axis of the piece. The trunnions of medium and light brass guns have shoulders, which are a tenth of the diameter of the trunnion in breadth, and of sufficient depth to clear the projection of the second reinforce rings.

The vent fields are $\frac{1}{17}$th of the breech and first reinforce.

The chase girdles are $\frac{1}{14}$th part of the chase.

The length of the muzzle is equal to the diameter of the second reinforce ring in heavy guns; and in medium guns $\frac{1}{7}$th of the length of the piece. The diameter of the swell of the muzzle is equal to the diameters of the second reinforce rings.

The bottom of the bores of heavy brass guns is a plain surface, meeting the sides in a small arc described with a radius of $\frac{1}{24}$th of a calibre: in medium and light guns they are hemispherical, and their vents form an angle of 75 degrees with the axis of the piece: making in light guns $\frac{1}{3}$rd of the calibre, and in medium $\frac{1}{4}$th of the calibre, from the extremity of the bore.

The vents of heavy guns are a fifth of an inch in diameter.

In medium and light guns there is a portion of metal beneath the neck of the cascable, for receiving the loop of the elevating screw. The lower part of it is the arc of a circle, described with a radius equal to the semidiameter of the neck: the position of the centre is $\frac{1}{4}$th part of the distance from the extremity of the breech moulding to that of the button, and is $\frac{1}{14}$th of the diameter of the neck below it.

Medium and heavy guns are cast with dolphins, by which they are occasionally suspended, and they consequently should be placed over the centre of gravity of them, or rather so that the breech may preponderate in a small degree.

The following Table shews the calibres of English guns of all sorts.

Pounders	42	32	24	18	12	9	6	4	3	1
Calibre in inches	7,018	6,410	5,824	5,292	4,623	4,328	3,608	3,204	2,913	2,019

Table of the length, weight, and calibres of brass guns, and of the diameter of their shot, and weight of powder for proof and service.

Brass guns.	Pounders.	Weight of powder for proof.	Length.	Weight of metal.	Calibre.	Diameter of the shot.	Weight of powder for service.
		lb. oz.	*ft. in.*	*ct. qr. lb.*	*in.*	*in.*	*lb. oz.*
Heavy	42	31 : 8	9 : 6	61 : 0 : 0	7,018	6,68	14 : 0
	24	21 : 12	9 : 6	53 : 0 : 9	5,824	5,54	8 : 0
	12	12 : 0	9 : 0	29 : 0 : 0	4,623	4,40	4 : 0
	9	9 : 0	9 : 0	26 : 0 : 0	4,200	4,00	3 : 0
	6	6 : 0	8 : 0	19 : 0 : 0	3,668	3,48	2 : 0
	3	3 : 0	7 : 0	11 : 2 : 0	2,913	2,77	1 : 0
	1½	1 : 8	6 : 0	5 : 2 : 0	2,310	2,20	0 : 8
Medium	24	18 : 0	8 : 0	40 : 1 : 21	5,824	5,45	8 : 0
	12	9 : 0	6 : 6	21 : 0 : 14	4,623	4,40	4 : 0
	6	6 : 0	5 : 0	10 : 1 : 12	3,668	3,48	2 : 0
Light	24	10 : 0	5 : 6	16 : 1 : 12	5,824	5,54	8 : 0
	12	6 : 0	5 : 0	8 : 3 : 18	4,623	4,40	4 : 0
	6	3 : 0	4 : 6	4 : 3 : 14	3,668	3,84	2 : 0
	3	1 : 8	3 : 6	2 : 3 : 4	2,913	2,77	1 : 0

N. B. The above charges for service are established by the Board of Ordnance; but in actual service they are commonly reduced to a third of the weight of the shot.

From the following dimensions of the wheels and axles of an heavy twelve pounder and of a light six pounder, some idea may be formed of the proportion of other parts of their carriages, and also of those of pieces of artillery of the other rates.

	Heavy 12 pounder.	Light 6 pounder.
	ft. in.	*ft. in.*
Diameter of the wheel	4 : 9,500	4 : 5,
Height of the axletree	0 : 8,250	0 : 6,
Thickness of ditto	0 : 6,625	0 : 5,250
Length of ditto	6 : 8,	5 : 3,

The bed of the 12 pounder is 3 feet 3 inches in length.

The most usual mode by which cannon are discharged is by applying a kindled match to the touch-hole. Locks, on a similar principle to musket locks, have been tried in sea service, and have been found to perform very well, but their use is by no means general.

A very great improvement has been made in matches by M. Leroy, who has found that small rods of lime-tree, and some other soft woods, prepared with infusion of nitrate

of lead, or nitrate of copper, form matches much superior to the common sort. For the method of making them, see the articles MATCH and PORTFIRE.

For the construction of iron guns for battering pieces, and garrison, and ship guns, mortars, howitzers, and for other particulars relative to artillery in general, see the articles CANNON, MORTARS, HOWITZERS, GUNNERY, and PROJECTILES.

It would appear at a superficial view, that the adoption of cannon and gunpowder in war had rendered it more bloody and destructive than the method of fighting and the arms formerly in use; but the reverse of this will be found in reality to have taken place. The chief contest in modern warfare is for posts and stations, where artillery can have such command of the adjoining ground as to give a material superiority; and as the chief combat is carried on from a distance, on a reverse of fortune the defeated have more opportunities of safe retreat. Hence mere extermination of an enemy ceases to be the ultimate design of war: when a post is seized, those under its influence no longer think of contending; the odds against their success are so excessive, that it ceases to be any disgrace to yield, and those become prisoners of war who in the ancient warfare must have been devoted to massacre. In the history of remote periods, we often read of 200,000 or more men entering the field of battle, and not more than a dozen or two escaping alive, and in a few instances not even so many. Such sanguinary terminations to engagements never now occur, and it often happens that in a long campaign not more lives are lost than formerly have perished in a single battle.

The following observations of Dr. Smith on the subject shew still more the advantage to mankind in general of the use of cannon, and other modern instruments of war.

"In modern war the great expense of fire-arms gives an evident advantage to the nation which can best afford that expense; and consequently to an opulent and civilized over a poor and barbarous nation. In ancient times the opulent and civilized found it difficult to defend themselves against the poor and barbarous nations. In modern times the poor and barbarous find it difficult to defend themselves against the opulent and civilized. The invention of fire arms, an invention which at first sight appears to be so pernicious, is certainly favourable both to the permanency and to the extension of civilization."

This circumstance alone reduces the Tartar hordes to comparative insignificance, who in ancient times were so formidable to the civilized world; who more than once have reduced it to primitive ignorance and barbarity, by the indiscriminate destruction of men of science and artists, and whose numbers, which have procured that part of the world they inhabit the name of the *officina gentium*, might be still an object of terror but for the use of cannon.

ARTILLERY, *flying*, a species of it, called so from the celerity with which it is moved from station to station.

Seats are contrived in the carriage and limbers of guns of this sort for the men who work it, and a sufficient number of horses are added to carry the whole at a gallop, when the ground will admit of this pace. Each horse is in general rode by a separate driver, and the men are all trained either to drive or work the gun, as occasion may require.

Flying artillery were first used by the French, shortly after their revolution, and materially assisted them in some of their most signal victories. Their use has now become general in Europe, and may be expected to increase.

ARTIST, in a general sense, a person skilled in some art; or, according to Mr. Harris's definition, a person possessing an habitual power of becoming the cause of some effect, according to a system of various and well-approved precepts. In this sense, we say, an excellent, a curious artist. The preeminence is disputed between ancient and modern artists, especially as to what relates to sculpture, painting, and the like. At Vicenza, we are told of a privilege granted to artists, like that of clergy in England; in virtue of this, criminals adjudged to death save their lives, if they can prove themselves the most excellent and consummate workmen in any useful art. This benefit is allowed them in *favorem artis*, for the first offence, except for some particular crimes, of which coining is one. The exception is just, since here the greater the artist, the more dangerous the person. Evelyn's Disc. of Medals, ch. vii. p. 237, &c. Artists are persons who practise those arts which must necessarily be combined with a considerable degree of science, distinguishing them from such as are properly artizans or mechanics. Artists are particularly those who study and effect what are termed the po-

polite arts, *i. e.* painting, sculpture, and architecture, to which may be added engraving. It appears that all civilized nations in every age have produced artists, and that with a degree of excellence, generally answerable to their civilization and opulence. In every nation where the arts have flourished, the artists have made but rude essays, and by degrees they have been nurtured up to excellence, except in such instances where they have been transplanted, as from Greece to Rome. It is universally acknowledged respecting statuary and architecture, that ancient Greece has produced the best artists in the world; their works, which have escaped the ravages of time, are the standing monuments of their fame, and are still considered as the models of perfection; there is, however, an uncertainty whether their painters were equally skilled with their statuaries. With some reason, many judicious persons have supposed they were not; while others contend, that so much excellence produced in one branch must have contemporary artists, who would excel in the other also. While we cannot doubt of the genius of the Grecian artists, and of their ability to produce works of excellence, yet it may not be allowed, that this argument will be found to be so conclusive as it may at first appear, since Chinese and Indian models are found in a more perfect state than either their drawings or paintings. When the Goths overran Italy, the arts were destroyed; and, with Grecian architecture, painting and sculpture lay in one common grave forgotten, until they revived under some artists in the twelfth and thirteenth centuries, who ought not to be named as artists, but for the succeeding effects to which their efforts prepared the way, and in a short time after produced Michael Angelo, Raphael, Correggio, Titian, Algardi, Bernini, &c. painters, sculptors, and architects, to whose works the living artists are almost as much indebted as these illustrious characters were to the ancient monuments they dug from the ruins of old Rome. See ARTS, *fine*.

ARTOCARPUS, in botany, *bread-fruit tree.* Class, Monoecia Monandria. Male flowers, cal. none; ament cylindrical, all covered with florets; cor. to each two petals, oblong, concave, blunt, villose.; stam. filament single, within each corolla, filiform, the length of the corolla; anther oblong. Female flowers, on the same tree: cal. and corolla none; pist. germs very many; connected into a globe, hexangular style to each, filiform; stigma single, or two, capillary, revolute; per. fruit ovate, globular, compound, muricate; seed for each germ solitary, oblong, covered with a pulpy aril, placed on an ovate receptacle. There are but two species, 1. A. incisa, which is the thickness of a man, and upwards of 40 feet high; the trunk is upright; the wood soft, smooth, and yellowish; the inner bark white, composed of a net of stiffish fibres, the outer bark smooth, but full of chinks, pale ash-colour, with small tubercles thinly scattered over it. Wherever the tree is wounded, it pours out a glutinous milky liquor. The branches form an ample almost globular head; the lower ones, which are the longest, spring from the trunk 10 or 12 feet above the ground, spreading almost horizontally, scattered, and in a sort of whorl; twigs ascending, bearing flowers and fruit at their ends. In captain Cook's voyage it is observed, that the bread-fruit tree is about the size of a middling oak; its leaves are frequently a foot and a half long, oblong, deeply sinuated, like those of the fig-tree, which they resemble in consistence and colour, and in exuding a milky juice when broken. The fruit is the size and shape of a child's head, and the surface is reticulated not much unlike a truffle; it is covered with a thin skin, and has a core about as big as the handle of a small knife; the eatable part lies between the skin and core; it is as white as snow, and of the consistence of new bread. It must be roasted before it is eaten, being first divided into three or four parts; its taste is insipid, with a slight sweetness, somewhat resembling that of the crumb of wheaten bread mixed with the Jerusalem artichoke. The fruit not being in season all the year, there is a method of supplying this defect, by reducing it to sour paste called makie; and besides this, cocoa-nuts, bananas, plantains, and a great variety of other fruits, come in aid of it. This tree not only supplies food, but also clothing, for the bark is stripped off the suckers, and formed into a kind of cloth. To procure the fruit for food costs the Otaheiteans no trouble or labour but climbing a tree; which though it should not indeed shoot up spontaneously, yet, as Captain Cook observes, if a man plant ten trees in his life time, he will as completely fulfil his duty to his own and future generations, as the native of our less temperate climate can do by ploughing in the cold winter, and reaping in the summer's heat, as often as these seasons return; even if after he has procured bread for his present household, he should convert a surplus into money, and lay it up for his children. But where the

trees are once introduced in a favourable soil and climate, so far from being obliged to renew them by planting, it seems probable that the inhabitants will rather be under the necessity of preventing their progress; for young trees spring abundantly from the roots of the old ones, which run along near the surface. Accordingly they never plant the bread-fruit tree at Otaheite. The bread-fruit is distinguished into that which is destitute of seeds, and that in which seeds are found. The natives of Otaheite reckon at least eight varieties of trees which produce the former. This most useful tree is distributed very extensively over the East Indian continent and islands, as well as the innumerable islands of the South Seas. In Otaheite, however, and some others, the evident superiority of the seedless variety for food has caused the other to be neglected, and it is consequently almost worn out. We are informed by Captain King, that in the Sandwich islands these trees are planted and flourish with great luxuriance on rising grounds; that they are not indeed in such abundance, but that they produce double the quantity of fruit which they do on the rich plains of Otaheite; that the trees are nearly of the same height, but that the branches begin to strike out from the trunk much lower, and with greater luxuriance; and that the climate of these islands differs very little from that of the West Indian islands, which lie in the same latitude. This reflection probably first suggested the idea of conveying this valuable tree to our islands in the West Indies. For this purpose his Majesty's ship, the Bounty, sailed for the South Seas, on the 23d of December, 1787, under the command of lieutenant William Bligh. But a fatal mutiny prevented the accomplishment of this benevolent design. His Majesty, however, not discouraged by the unfortunate event of the voyage, and fully impressed with the importance of securing so useful an article of food as the bread-fruit, to our West Indian islands, determined, in the year 1791, to employ another ship for a second expedition on this service; and, in order to secure the success of the voyage as much as possible, it was thought proper, that two vessels should proceed together on this important business. Accordingly, a ship of 400 tons, named the Providence, was engaged for the purpose, and the command of her given to captain Bligh; and a small tender, called the Assistant, commanded by lieutenant Nathaniel Portlock. Sir Joseph Banks, as in the former voyage, directed the equipment of the ship for this particular purpose. Two skilful gardeners were appointed to superintend the trees and plants, from their transplantion at Otaheite, to their delivery at Jamaica; and captain Bligh set sail on the 2d of August, 1791. The number of plants taken on board at Otaheite, was 2634, in 1281 pots, tubs, and cases; and of these 1151 were bread-fruit trees. When they arrived at Coupang, 200 plants were dead, but the rest were in good order. Here they procured 92 pots of the fruits of that country. They arrived at St. Helena with 830 fine bread-fruit trees, besides other plants. Here they left some of them, with different fruits of Otaheite and Timor, besides mountain rice and other seeds; and from hence the East Indies may be supplied with them. On their arrival at St. Vincent's, they had 551 cases, containing 678 bread-fruit trees, besides a great number of other fruits and plants, to the number of 1245. Near half this cargo was deposited here under the care of Mr. Alexander Anderson, the superintendant of his Majesty's botanic garden, for the use of the Windward islands; and the remainder, intended for the Leeward islands, was conveyed to Jamaica, and distributed as the Governor and Council of Jamaica were pleased to direct. The exact number of bread-fruit trees brought to Jamaica was 352, out of which five only were reserved for the botanic garden at Kew. Though the principal object of this voyage was to procure the bread-fruit tree, yet it was not confined to this only; for the design was to furnish the West Indian isles with the most valuable productions of the South Seas and the East Indies. Captain Bligh had the satisfaction, before he quitted Jamaica, of seeing the trees which he had brought with so much success, in a most flourishing state; insomuch that no doubt remained of their growing well, and speedily producing fruit; an opinion which subsequent reports have confirmed. But though the fruit has been produced in great abundance, it is said not yet to have arrived at that high state of perfection in which it is described to be at Otaheite. Thunberg sent seeds of the East Indian bread-fruit tree from Batavia to the botanic garden at Amsterdam, in 1775. In 1777, he sent some small living plants; and the year following, he brought with him to Europe a great number of plants, both of this and the following species. But the true seedless sort, from the South Seas, was first introduced into the islands of St. Vincent and Jamaica, and into

the botanic garden at Kew, by captain Bligh, in 1793. The bread-fruit, when perfectly ripe, is pulpy, sweetish, putrescent, and in this state is thought to be too laxative; but when green it is farinaceous, and esteemed a very wholesome food, either baked under the coals, or roasted over them. The taste is not unlike that of wheaten bread, but with some resemblance to that of Jerusalem artichokes, or potatoes. It was mentioned before, that a sort of cloth was made of the inner bark: to this we may add, that the wood is used in building boats and houses; the male catkins serve for tinder; the leaves for wrapping their food in, and for wiping their hands instead of towels; and the juice for making bird-lime, and as a cement for filling up the cracks of their vessels for holding water. Three trees are supposed to yield sufficient nourishment for one person. 2. A. integrifolia, Indian jacca tree. The East Indian jacca, or jack tree, is about the same size as the foregoing, or perhaps larger. The foot-stalk is somewhat triangular, smooth, and an inch in length. The fruit weighs 30 pounds and upwards; it has within it frequently from two to three hundred seeds, three or four times as big as almonds; they are ovate-oblong, blunt at one end, sharp at the other, and a little flatted on the sides.

These two species of Artocarpus cannot be distinguished with certainty either by the form of the leaves, or the situation of the fruit; for the leaves in this are sometimes lobed as on that; and the situation of the fruit varies with the age of this tree, being first borne on the branches, and then on the trunk, and finally on the roots. The jacca tree is a native of Malabar and the other parts of the East Indies. The fruit is ripe in December, and is then eaten, but is esteemed difficult of digestion; the unripe fruit is also used pickled, or cut into slices and boiled, or fried in palm oil. The nuts are eaten roasted, and the skin which immediately covers them, is used instead of the areca nut in chewing betel. The wood of the tree serves for building. No less than 30 varieties of the fruit are enumerated in Malabar. It was introduced into the royal botanic garden at Kew, in 1778, by Sir Edward Hughes, Knight of the Bath.

ARTS, *fine*. The Fine Arts may be properly defined those which, blending elegant ornament with utility, convey intellectual pleasure to the mind, through the medium of the fancy or imagination. They are termed elegant or fine arts, not in opposition to those which are necessary or useful, but to distinguish them from such as are necessary or useful only.

The arts, generally distinguished by the appellation fine, are Poetry, Music, Painting, Sculpture, and Engraving, with their several branches. To these we may not improperly add Dancing, and also Architecture; for the latter, although in its origin it was merely appropriated to purposes of utility, has certainly, by its various proportions, modes, and embellishments, become highly ornamental and impressive to the imagination.

It is perhaps scarcely within the scope of a work of this kind, intended for the promulgation of the best-established doctrines on the various branches of human knowledge, rather than as a receptacle for novel and dubious conjecture, to discuss how far the general sense in which a term is understood includes its full and entire meaning; otherwise it might not be impossible to show that many branches of art or science, besides the above mentioned, have an inseparable connection with the fine arts; and that, of consequence, their influence at least, if not their dominion, is much more widely extended than is commonly supposed.

If between poetry and painting there really subsist that close affinity which has been so generally allowed, if they are daughters of the same parent, if their object be the same, the mode by which they accomplish that object alone different, if painting is mute poesy, and the poem a speaking picture; may we not reasonably conclude that there exists some great rule, some primary principle, common to both; and hope, by tracing the conduct of the one art, to throw some additional light on the other? Perhaps the result of an investigation upon the nature and boundaries of the art of poetry would, by analogy, at once bring us to this conclusion, that it is impossible to define the precise limits of the fine arts in general, or what is alone their object.

Although metre or versification be necessary to constitute what is strictly called poesy, still it is by all admitted and felt, that it is the last qualification of a great poet; and hence a noble author, (Lord Landsdown) observes, that "Versification is in poetry what colouring is in painting, a beautiful ornament." "But," he adds, "if the proportions are just, the posture true, the figure bold, and the resemblance ac-

cording to nature, though the colours happen to be rough, or carelessly laid on, yet the picture shall lose nothing of its esteem." But if skill in versification be the least, what are then the greater qualities which constitute the poet? The question is easily answered: those very qualities which, in a greater or less degree, are requisite to the formation of an elegant speaker or writer, on almost any subject, whether in prose or verse, with the exception of those of profound or abstruse science. And indeed the different species of prose writers have, from time to time, made such encroachments on what is perhaps more peculiarly the province of poetry; and the poets have, as it were in revenge, adopted so many of those subjects which belong more properly to prose, that the chief difference now remaining between the two parties seems to be, that the latter express their thoughts through the medium of metre or rhyme, and the former without that ornament. Who will deny the title of poet to the authors of Telemachus and the Death of Abel? And who will deny, that some of those treatises which have employed the ingenuity of poets, under the title of didactic poems, would better have attained the object of instruction and conviction to the reader, had they been written in the energetic prose of a Bacon, a Swift, or a Johnson?

That a similitude between poetry and painting, as before mentioned, really subsists, there can be little doubt; nor would it be difficult to point out instances of productions in each of these arts, as well as of music, so resembling in character as to seem, as it were, different emanations from one spirit, and alike calculated to excite kindred sensations in the breast of the hearer or spectator. But, however close the comparison might have been at the period when that comparison was first made, when each art was, in fact, applied to effect similar purposes, though through different means; it is certain that since the objects of their pursuit have become more varied and extended, the propriety of the comparison between them has proportionably diminished.

But if, instead of contenting ourselves with retracing the old parallel of poetry with painting, we were to take a wider range, and consider the arts of design as a mode of conveying ideas, or as analogous to language or writing in general, such an inquiry might lead us to a just appreciation of their importance, by exhibiting a comprehensive view of the extent of their powers, and of the modes of applying those powers as means for the attainment of any desired end.

The arts of design we may then consider as a language, by which, though all things cannot be expressed, many at least may, in a stronger and clearer manner than can be effected by any other. And it is scarcely necessary to add, that, all those arts or sciences to the comprehension or practice of which lineation or modelling is requisite, are more or less dependent on design.

The arts of design, or those dependent on design, may be divided into three great classes: arts, simply useful or necessary; arts, whose object it is to unite elegance with utility; and arts, whose aim is more decidedly to elevate the human mind, by an appropriate choice of the most grand and beautiful objects.

Design, so far as it is requisite for the common purposes of life, as building dwelling-houses, planning convenient furniture, forming canals, raising aqueducts, &c. is a useful, or indeed a necessary art. Without design, by which the explanatory figures are furnished, the first principles of geometry and the mathematics, the foundation of so large a portion of human knowledge, would be unintelligible. Without design we should be ignorant of the situations and bearings of different countries; without the assistance of maps and charts, the pilot would be ignorant what course to steer; nay, the compass itself may be termed the offspring of design. By her means, without the constant recurrence to dissection, the physician and surgeon are instructed in the various situations and appearances of the bones, veins, nerves, muscles, and every other part of the human frame; and, by her assistance, the visible symptoms of disorders can be accurately described, when words would have been inadequate to the task.

If we consider design as applicable to those arts, sciences, or manufactures, whose object it is to combine utility and instruction with ornament and amusement, we shall find her province not less extended. The chair, the sofa, the table, and the lamp, no longer confined to the purposes of mere necessity, present themselves, adorned with all the graces of Grecian art, at once the instruments of our comfort, and the embellishment of our apartments. By means of design, we are transported to foreign climes; we behold their buildings, pro-

cessions, dresses, &c.: with her assistance, the traveller is enabled to teach us their customs and manners, and instruct us in the process of their manufactures; the deepest recesses of the earth are laid before us, and the whole animal creation, with the wonders of the deep, are not withheld from our view.

The arts of design, considered more strictly as elegant arts, have a no less extensive and noble scope: our edifices rise with majestic beauty; the column, the obelisk, and the statue perpetuate the remembrance of departed worth; whilst the picture excites us, by its representations, to emulate the heroic deeds of former times, or transports us to the alluring regions of fancy.

We have perhaps said sufficient to shew the difficulty, nay, the impossibility of defining the precise limits of the fine arts in general. Of each in particular it is not our intention here to speak, nor shall we undertake a laborious and unprofitable inquiry respecting the pretensions of any one of them to priority of existence or superiority of rank. Each has its allotted office, and they journey on, hand in hand, reciprocally decorating and assisting each other, the coeval, and perhaps the coequal offspring of the same parent. See POETRY, PAINTING, DRAWING, SCULPTURE, ENGRAVING, ARCHITECTURE, MUSIC, and DANCING.

ARUM, in botany, a genus of plants of the Monoecia Hexandria class and order. Spathe one-leafed, convolute at the base; spadix cylindrical, androgynous, naked above, bearing the stamina in the middle, and the germs at the base. There are three divisions, and upwards of thirty species. A. without stems; leaves compound. B. without stems; leaves simple. C. caulescent. Of the species we notice 1. A. dracontium, dragon, which has a large, tuberous, fleshy root, which in the spring puts up a straight stalk about 3 feet high, spotted like the belly of a snake; at the top it spreads out into leaves, which are cut into several narrow segments almost to the bottom; at the top of the stalk the flower is produced, which has so strong a scent of carrion, that few persons can endure it. It grows naturally in most of the southern parts of Europe, and is preserved in gardens to supply the markets with the roots which are used in medicine. 2. A. maculatum, cuckow-pint, wake robin: the common appellation is *lords and ladies*, and in Worcestershire, it is called *bloody men's fingers*. It is a native of most parts of Europe, except the very northern ones, in shady places, and on the banks of ditches: flowering in May. The berries ripen at the close of summer. The root and leaves of arum when recent are extremely acrid, and affect the tongue with a pungency as if it were pricked with needles. This sensation may be alleviated by milk, butter, or oil. When dried, they may be used for food in case of necessity. The root dried and powdered is used by the French as a wash for the skin, and is sold under the name of cypress powder. 3. A. seguinum, dumb-cane arum, grows naturally in the sugar islands, and other warm parts of America, chiefly in the low grounds; the plants abound in acrid juice, so that if a leaf or a part of the stalk be broken, and applied to the tip of the tongue, it causes a very painful sensation, and such an irritation, as to prevent a person from speaking, hence its name in Jamaica, where it is said they sometimes rub the mouths of their negroes with it by way of punishment. The stalk is used to bring sugar to a good grain, when the juice is too viscid, and cannot be brought to granulate with lime.

ARUNA, in botany, a genus of the Diandria Digynia class and order. Gen. char. calyx four-parted, the divisions reflected; berry one-celled, one or two-seeded. There is but a single species, a tree with wide spreading branches found in Guiana.

ARUNDELIAN *marbles*, called also the Parian Chronicle, are supposed to be ancient stones, on which is inscribed a chronicle of the city of Athens, engraven in capital letters in the island of Paros, one of the Cyclades, 264 years before the Christian æra. They are frequently denominated Oxford marbles, and derive their name either from the Earl of Arundel, who procured them out of the east, or from his grandson, who presented them to the University of Oxford: in the former case they are called Arundelian, and in the latter, Oxford marbles. These and other ancient relicts were purchased in Asia Minor, Greece, and the islands of the Archipelago, by Mr. William Petty, who was employed, in the year 1624, by the Earl of Arundel for the purpose. They arrived in England about the year 1627, and were placed in the gardens belonging to Arundel house in London. Having excited a considerable share of curiosity among the learned, Mr. Selden undertook to explain the Greek inscriptions, which he did in a small quarto

volume under the title of "Marmora Arundeliana," containing nearly forty inscriptions with annotations. During the civil wars, these marbles were defaced and much injured, and some of them entirely lost, or made use of for the ordinary purposes of building. In 1667, what were left of these curious remains were presented to the University of Oxford, when a new edition of Selden's work was published, with additional notes, by the celebrated Dr. Prideaux. Mr. Mattaire in 1731, gave the public a more comprehensive view of these marbles, and in 1763, Dr. Chandler published a new and improved copy of them, in which he corrected the errors of the former editors, and supplied the deficiencies in some of the inscriptions, particularly those of the Parian chronicle, by many ingenious conjectures. These marbles, in their perfect state, contained a chronological detail of the principal events of Greece, from the commencement of the reign of Cecrops, in the year before Christ 1582, to the close of the archonate of Diognetus, in the year 264, A. C. The chronicle of the last 90 years is lost, and the others are much defaced and corroded, of course the sense can only be discovered by very learned and industrious antiquaries, or supplied by conjectures. Almost every event in this table between the destruction of Troy and the annual magistracy of Athens, is dated 26 years earlier than in the canons of Eusebius, and those of other approved chronologers. These marbles have been applied to the elucidation of many parts of ancient history; but their inconsistency with other authentic records, has depreciated their value and use. Their authenticity has been doubted, and the question ably discussed by Mr. Robertson and Mr. Hewlett, the former being inclined to give up, and the latter to vindicate the authenticity of the Parian chronicle.

ARUNDO, *common reed,* in botany, a genus of the Triandria Digynia class of plants, the calyx of which is a glume formed of two oblong, acuminated valves, not aristated, one longer than the other. The corolla is formed of two valves of the length of the cup, of an oblong, acuminated figure, with a lanuginous matter at the base, of the length of the flower; the corolla adheres to the seed, and serves as a pericarpium; the seed is single, oblong, pointed, and downy at the base. There are 14 species, of which we notice 1. A. bambos, bamboo-cane, which has a woody, hollow, round, straight culm, forty-feet high and upwards, simple and shining; it grows naturally almost every where within the tropical regions. Over a great part of Asia it is very common. It has been long cultivated here. Some of the plants have been seen twenty feet high; a strong shoot from the root has been known to grow twenty feet in five or six weeks. See BAMBOO. 2. A. phragmites, the common reed, which flowers from July to September, and is common by the sides of rivers, in ditches, and large standing waters. In autumn, when the leaves begin to fall, and the stems are changed brown, it is cut for making screens in kitchen gardens, and for many other uses, as thatching, for which it is more durable than straw; for ceilings, and to lay across the frame of wood-work as the foundation for plaister floors. The panicles are used by the country people in Sweden to dye wool green.

ARUSPICES, or HARUSPICES, an order of priesthood, among the Romans, that pretended to foretel future events by inspecting the entrails of victims killed in sacrifice; they were also consulted on occasion of portents and prodigies. It appears that women were admitted into this order.

AS, in antiquity, a particular weight, consisting of twelve ounces; being the same with libra, or the Roman pound.

As was also the name of a Roman coin, which was of different matter and weight, according to the different ages of the commonwealth.

It is also used to signify an integer, divisible into twelve parts, from which last acceptation it signified a whole inheritance. The as had several divisions, the principal of which were the uncia, or ounce, being the twelfth part of the as; sextans, the sixth part of the as; quadrans, the fourth part; triens, the third part; and semis, half the as, or six ounces. Bes was two thirds of the as, or eight ounces; and dodrans, three-fourths of the as.

ASAFŒTIDA, in chemistry, a gum resin obtained from ferula asafœtida, a perennial plant which is a native of Persia. When the plant is about four years old its roots are dug up and cleaned, and from their extremity when cut, a milky juice exudes, which soon hardens and constitutes asafœtida. It comes into this and other countries in Europe in small grains

of different colours, hard and brittle. Its taste is acrid and bitter, its smell is strongly alliaceous and fetid. Alcohol dissolves $\frac{3}{4}$ths of this substance, and water takes up about $\frac{1}{4}$th, if applied before the spirit. It yields an oil when distilled with water and alcohol. The specific gravity is 1.32.

ASARUM, or ASARABACCA, in botany, a genus of plants without any flower-leaves, and belonging to the Dodecandria Monogynia class of Linnæus. Its fruit is a coriaceous capsule, divided into six cells, and containing a great many oval seeds. There are three species. The common asarabacca is a native of many parts of Europe, in woods and shady places, flowering in April and May. With us it is found only in Lancashire. The root finely powdered excites vomiting; coarsely powdered it purges. The powder of the leaves is the basis of most cephalic snuffs, which occasion a considerable discharge of mucus from the nostrils without much sneezing.

ASBESTUS, in mineralogy, a species of the Talc family, well known to the ancients, who made a kind of cloth from one of the varieties, which was famous for its incombustibility. It is found in primitive mountains, especially in serpentine, which it traverses in veins. It is divided by Werner into four sub-species, *viz.* 1. The elastic asbest, or rock cork, which is of a yellowish grey, of various intensity: occurs sometimes massive, sometimes in plates, and with impressions. At first sight it appears to be fine grained, uneven. Opaque very seldom; translucent on the edges; somewhat elastically flexible; cracks when handled. Specific gravity .09 to .068. 2. The amianthus, of a greenish white, passing into a greenish grey, sometimes blood red. Massive, also in plates and small veins, and in capillary crystals. Internally its lustre is glistening, passing to shining: fracture parallelly fibrous, and sometimes a little curved. It is found in primitive rocks, in Sweden, Bohemia, Silesia, Italy, Hungary, Siberia, France, Spain, and Scotland. From its flexibility, and its resisting the effects of fire, it is said to have been by the ancients woven into a kind of cloth, in which they wrapped the bodies of persons of distinction before they were placed on the funeral pile, that their ashes might be collected free from admixture. It was also used for incombustible wicks; but is now considered only as an object of curiosity. To these may be added, 3. The common asbestus; and 4. The rock-wood, which differ too little from the former sub-species to demand particular notice. According to Cheneviz, the amianthus consists of

Silica......	59.0
Magnesia.	25.0
Lime......	9.25
Alumina..	3.0
Iron... ...	2.25
	98.5
Loss	1.5
	100.—

ASCARINA, in botany, a genus of the Dioecia Monandria class and order. Ament filiform; no corolla. Male, anthera worm-shaped, four-grooved: female, stigmata three lobed: drupe? One species, in the Society Isles.

ASCARIS, in natural history, a genus of worms of the order Intestina. Body round, elastic, and tapering towards each extremity; head with three vesicles; tail obtuse or subulate; intestines spiral: milk white and pellucid. There are about 80 species; separated into divisions, *viz.* A. infesting mammalia; B. found in birds; C. infesting reptiles; D. infesting fish; and E. infesting worms. A. vermicularis: head subulate; skin at the sides of the body very finely crenate, or wrinkled: inhabits the intestines of children and thin people, principally in the rectum. They are generally found in considerable numbers, and occasion many troublesome symptoms, creeping sometimes up into the stomach. They are viviparous, and about half an inch long. The female has a small punctiform aperture a little below the head, through which the young are protruded. A. lumbricus, inhabits the intestines of thin persons, generally about the ileum, but sometimes ascends into the stomach, and creeps out of the mouth and nostrils. They are frequently very numerous and vivacious, from twelve to fifteen inches long: body transparent, of a light yellow, and with a faint line down the side. They are oviparous, and distinguished from the earth worm, in wanting the fleshy ring below the head, and in having three vesicles.

ASCENSION, in astronomy, the rising of the sun or a star, or any part of the equinoctial with it, above the horizon: is either right or oblique.

Right ascension is that degree of the equator, reckoned from the beginning of Aries, which rises with the sun or a star, in a

right sphere. It is found by the following proportion. As the radius to the cosine of the sun or star's greatest declination, so is the tangent of the distance from Aries to Libra, to the tangent of right ascension.

Oblique ascension is that degree and minute of the equinoctial, counting from the beginning of Aries, which rises with the centre of the sun or a star, or which comes to the horizon at the same time as the sun or star, in an oblique sphere. In order to find the oblique ascension we must first find the ascensional difference.

The arch of right ascension coincides with the right ascension itself, and is the same in all parts of the globe. The arch of oblique ascension coincides with the oblique ascension, and changes according to the latitude of places.

The sun's right ascension in time is useful to the practical astronomer in regular observatories, who adjusts his clock by sidereal time. It serves also for converting apparent into sidereal time; as *e. g.* that of an eclipse of Jupiter's satellites, in order to know at what time it may be expected to happen by his clocks. For this purpose, the sun's right ascension at the preceding noon, together with the increase of right ascension from noon, must be added to the apparent time of the phenomenon set down in the ephemeris. The sun's right ascension in time serves also for computing the apparent time of a known star's passing the meridian: thus, subtract the sun's right ascension in time at noon from the star's right ascension in time, the remainder is the apparent time of the star's passing the meridian nearly; from which the proportional part of the daily increase of the sun's right ascension from this apparent time from noon being subtracted, leaves the correct time of the star's passing the meridian. The sun's right ascension in time is also useful for computing the time of the moon and planets passing the meridian. The practical method of finding the right ascension of a body from that of a fixed star, by a clock adjusted to sideral time, is this: let the clock begin its motion from $0^h\ 0'\ 0''$ at the instant the first point of Aries is on the meridian; then, when any star comes to the meridian, the clock would shew the apparent right ascension of the star, the right ascension being estimated in time at the rate of 15° an hour, provided the clock was subject to no error, because it would then shew at any time how far the first point of Aries was from the meridian. But as the clock is liable to err, we must be able at any time to ascertain its error, or the difference between the right ascension shewn by the clock and the right ascension of that point of the equator which is at that time on the meridian. To do this we must, when a star, whose right ascension is known, passes the meridian, compare its apparent right ascension with the right ascension shewn by the clock, and the difference will shew the error of the clock. *E. g.* Let the apparent right ascension of Aldebaran be $4^h\ 23'\ 50''$ at the time when its transit over the meridian is observed by the clock; and suppose the time shewn by the clock to be $4^h\ 23'\ 52''$, then there is an error of $2''$ in the clock, as it gives the right ascension of the star $2''$ more than it ought. If the clock be compared with several stars, and the mean error taken, we shall have more accurately the error at the mean time of all the observations. These observations, being repeated every day, will give the rate of the clock's going, or shew how much it gains or loses. The error of the clock and the rate of its going being thus ascertained, if the time of the transit of any body be observed, and the error of the clock at the time be applied, we shall have the right ascension of the body. This is the method by which the right ascension of the sun, moon, and planets are regularly found in observatories. To find the right ascensions mechanically by the globe, see Globes, *the use of.* The arch of right ascension is that portion of the equator intercepted between the beginning of Aries and the point of the equator which is in the meridian: or it is the number of degrees contained in it. This coincides with the right ascension itself. The right ascension is the same in all parts of the globe. We sometimes also say, the right ascension of a point of the ecliptic, or any other point of the heavens. The right ascension of the mid-heaven is often used by astronomers, particularly in calculating eclipses by the nonagesimal degree; and it denotes the right ascension of that point of the equator which is in the meridian, and is equal to the sum of the sun's right ascension and the horary angle or true time reduced to degrees, or to the sum of the mean longitude of the sun and mean time.

ASCENSIONAL *difference*, the difference between the right and oblique ascension in any point of the heavens; or it is the space of time that the sun rises or sets before or after six o'clock.

The ascensional difference may be found by this proportion, *viz.* As the radius is to

the latitude of the place, so is the tangent of the sun's declination to the sine of the ascensional difference; by subtracting of which from the right ascension, when the sun is in the northern signs, and adding it, when the sun is in the southern ones, you will find the oblique ascension.

ASCENT *of fluids* is particularly understood of their rising above their own level, between the surfaces of nearly contiguous bodies, or in slender capillary glass tubes, or in vessels filled with sand, ashes, or the like porous substances. This effect happens as well in vacuo as in the open air, and in crooked as well as straight tubes. Some liquors, as spirit of wine and oil of turpentine, ascend with greater celerity than others; and some rise after a different manner from others. Mercury does not ascend at all, but rather subsides. Upon the same principle, two smooth polished plates of glass, metal, stone, or other matter, being so disposed as to be almost contiguous, have the effect of several parallel capillary tubes; and the fluid rises in them accordingly: the like may be said of a vessel filled with sand, &c. the divers little interstices of which form as it were a kind of capillary tubes: so that the same principle accounts for the appearance in them all. And to the same may probably be ascribed the ascent of the sap in vegetables. Thus Sir I. Newton says, if a large pipe of glass be filled with sifted ashes, well pressed together, and one end dipped into stagnant water, the fluid will ascend slowly in the ashes, so as in the space of a week or fortnight to reach the height of 30 or 40 inches above the stagnant water. This ascent is wholly owing to the action of those particles of the ashes which are upon the surface of the elevated water; those within the water attracting as much downwards as upwards: it follows, that the action of such particles is very strong; though being less dense and close than those of the glass, their action is not equal to that of glass, which keeps quicksilver suspended to the height of 60 or 70 inches, and therefore acts with a force which would keep water suspended to the height of about 60 feet. By the same principle a sponge sucks in water; and the glands in the bodies of animals, according to their several natures and dispositions, imbibe various juices from the blood. If a drop of oil, water, or other fluid, be laid on a glass plane, perpendicular to the horizon, so as to stand without breaking or running off, and another plane inclined to the former so as to meet at top, be brought to touch the drop, then will the drop break, and ascend towards the touching end of the planes; and it will ascend the faster in proportion as it is higher, because the distance between the planes is constantly decreasing. After the same manner the drop may be brought to any part of the planes, either upward, or downward, or sideways, by altering the angle of inclination. Lastly, if the same perpendicular planes be so placed as that two of their sides meet, and form a small angle, the other two only being kept apart by the interposition of some thin body, and thus immerged in a fluid tinged with some colour; the fluid will ascend between the planes, and this the highest where the planes are nearest, so as to form a curve line, which is found to be a just hyperbola, one of the asymptotes whereof is the line of the fluid, the other being a line drawn along the touching sides. The physical cause in all these phenomena is the same power of attraction.

ASCIDIA, in natural history, a genus of worms, of the order Mollusca. Body fixed, roundish, and apparently issuing from a sheath: two apertures, generally placed near the upper end, one beneath the other. There are more than 40 species found in the sea, adhering by their base to rocks, shells, and other submarine substances. They are more or less gelatinous, and have the power of squirting out the water which they take in. Some of them are esculent; most of them sessile, though a few are furnished with a long stalk, or tubular stem. They alternately contract and dilate themselves.

ASCII, among geographers, an appellation given to those inhabitants of the earth, who, at certain seasons of the year have no shadow: such are all the inhabitants of the torrid zone, when the sun is vertical to them.

ASCIUM, in botany, a genus of the Polyandria Monogynia class and order. Character: calyx five-leaved; petals five; berry four-celled, with two seeds in each. One species in Guiana, a tree 80 feet high.

ASCLEPIAS, *swallow-wort*, in botany, a genus of the Pentandria Digynia class of plants, the calyx of which is a permanent perianthium, divided into five acute and small segments; the corolla consists of a single petal, divided into five deep segments at the mouth; and its fruit consists of two follicles or vaginæ, containing a great number of imbricated seeds, winged with down. There are about 40 species. The swallow-

worts are either shrubs or tall upright perennial herbaceous plants, milky and poisonous, or at least acrid. The flowers are borne on solitary peduncles, several together in umbels, and surrounded with a many-leaved involucre. They are very singular in their structure. Flies in searching for the honey in the nectary are frequently caught by the legs, and are not able to extricate themselves. A. syriaca is a native of North America, where the tender shoots are eaten as we eat asparagus. The flowers are so odoriferous as to make it very agreeable to travel in the woods, especially in the evening. They make a sugar of them in Canada, gathering them in the morning, when they are covered with dew. Poor people collect the cotton from the pods, and fill their beds with it.

ASCOBOLUS, a genus of the Cryptogamia Fungi. Fungus semi-spherical, containing oblong vesicles, somewhat immersed in its disk, which eject the seeds with an elastic force.

ASCOPHORA, a genus of the Cryptogamia Fungi. Fungus erect, on a setaceous stalk; head globular-oblong; inflated, opake, elastic, bearing the seeds externally. There are seven species, and two divisions. A. clustered on a common receptacle. B. detached.

ASCYRUM, in botany, a genus of plants with a rosaceous flower, and an oblong capsular fruit, formed of two valves, and containing a number of small, roundish seeds. It belongs to the Polyadelphia Polyandria class of Linnæus, and is so nearly allied to the Hypericum, that Tournefort makes it the same genus; from which, however, it is distinguished by having only four petals, whereas the hypericum has five.

ASH, in botany. See FRAXINUS.

ASILUS, in natural history, a genus of insects of the order Diptera. Essential character: mouth with a straight, horny, bivalve snout. The most common European species of asilus is the A. crabroniformis, a moderately large insect, nearly equalling a hornet in length, but of a much more slender and sharpened form: the head and thorax are of a ferruginous colour: the eyes black: the upper half of the abdomen velvet black; the lower half bright orange colour; the whole having a bright silky or downy surface: the wings are a dull yellow brown, and marked on their inner edge by several dusky triangular dashes of spots. Though of a somewhat formidable aspect, this insect is incapable of piercing with any degree of severity. It preys on the smaller kind of insects, and proceeds from a smooth, white, subterraneous larva, of lengthened shape, and destitute of legs: the pupa resembles that of the tipula. There are several other species.

ASPALATHUS, *aspalath*, in botany, a genus of the Diadelphia Decandria class of plants, the calyx of which consists of a single-leafed perianthium, divided into five segments: the corolla is papilionaceous; the fruit is a roundish, turgid, unilocular, bivalve pod; the seed is single, and frequently kidney-shaped. According to Martyn there are 37 species; but Gmelin has enumerated nearly double that number. The plants of this genus, with few exceptions, are natives of the Cape of Good Hope. They are shrubby, or at least under-shrubs. The leaves are simple: the flowers mostly yellow. They may be propagated here by seeds brought from the Cape.

ASPARAGIN, a name given to a lately discovered juice of asparagus, which was discovered by expression and evaporation. Various crystals gradually make their appearance, and among others crystals of asparagin easily separated from the rest on account of their colour and figure. The crystals are white and transparent, and have the figure of rhomboidal prisms: it is hard and brittle, and its taste is cool and slightly nauseous, so as to occasion a secretion of saliva. It dissolves in hot water, but not in alcohol. The aqueous solution does not affect vegetable blues. Neither infusion of galls, acetate of lead, oxalate of ammonia, muriate of barytes, nor the hydro-sulphurat, occasion any change in it. When triturated with potash no ammonia is disengaged. When heated it smells, and emits penetrating vapours, affecting the eyes and nose like the smoke of wood. Nitric acid dissolves it with the evolution of nitrous gas. These properties distinguish it from all other vegetable substances.

ASPARAGUS, in botany. Class, Hexandria Monogynia. Gen. char. cal. none; cor. petals, six, cohering by the claws, oblong, erected into a tube, three alternately interior, permanent; stam. filaments six, filiform, inserted into the petals, erect, shorter than the corolla; anthers roundish; pist. germ. turbinate, three-cornered; style very short; stigma, a prominent point; perberry globular, umbilicated with a point, three-celled; seeds two, round, angular on the inside, smooth.

ASPARAGUS, in gardening, comprehends

one of the most valuable esculent vegetables of the kitchen-garden; it has erect, herbaceous stalks, three or four feet in height, and very fine bristly leaves: it is a perennial fibrous-rooted vegetable, the roots being of many years duration, but the tops or stalks annual. The plants being raised from seed, after having acquired a period of three or four years growth, produce proper sized asparagus, of which the same roots furnish an annual supply for many years, continuing to rise in perfection for six or eight weeks in the summer season, the shoots afterwards run up to stalks and flowers, and perfect seeds in autumn. But besides the crop raised in the summer season, it may also be obtained in perfection during the winter, and early in the spring, by the aid of hot-beds.

Asparagus is always three years at least, from the time of sowing the seed, before the plants obtain strength enough to produce shoots of due size for the table; that is, one year in the seed-bed, and two after being transplanted, though it is sometimes three or four years after planting before they produce good full-sized shoots. But the same bed or plantation will continue producing good asparagus ten or twelve years, and even endure fifteen or twenty years. However, at that age the shoots are generally small, and the whole annual produce inconsiderable. A new plantation should, therefore, be made every eight, ten, or twelve years, as may be judged necessary. When new plantations of asparagus are required to be raised in the quickest manner for use, it should be done by purchasing ready-raised year-old plants of the nursery-men or kitchen-gardeners, as in this way a year may be gained.

Asparagus, in chemistry. This plant has been lately analyzed: the filtered juice had the appearance of whey, and reddened the infusion of litmus. When heated, it deposited flakes, which were considered as albumen. When left a long time to evaporate in the open air, a quantity of asparagin, and of saccharine matter, having the appearance of manna, separated in crystals. See Asparagin.

Asparagus *stone*, in mineralogy, found only at Caprera in Murcia, a province of Spain, which has been considered by some French chemists as a chrysolite. Colour, asparagus-green, sometimes passing to a greenish white or pistachio-green, sometimes between orange and yellowish brown; always crystallized in equiangular six-sided prisms; frangible, brittle. Specific gravity 3.09. It dissolves in the nitrous acid with effervescence, but does not exhibit a phosphoric light when laid on coals. Its constituent parts are,

Lime	53.32
Phosphoric acid	45.72
	99.04

ASPERUGO, in botany, a genus of the Pentandria Monogynia class of plants, the flower of which consists of one rotated petal, divided into several segments at the limb; and its calyx, which is divided like the flower-petal, contains the seeds, which are four in number, and of a roundish compressed figure. There are two species.

ASPERULA, *woodruffe*, in botany, a genus of the Tetrandria Monogynia class of plants, the flower of which consists of one petal, divided into four segments at the limb; and its fruit is composed of two roundish, dry berries, adhering together, in each of which is a single seed of the same roundish shape.

There are eleven species. The common sweet-scented woodruffe is a native of many parts of Europe, in woods and shady places. The scent is pleasant, and when dried, diffuses an odour like that of vernal grass. It gives a grateful flavour to wine; and when kept among clothes, it not only imparts an agreeable perfume to them, but is said to preserve them from insects.

ASPHALTUM, in chemistry, one of the proper bitumens, found in great abundance in different countries, especially in the island of Trinidad, on the shores of the Red Sea, and in Albania, where it is found in vast strata. It is supposed that it was first liquid, and that it acquired solidity by exposure to the air. Its colour is black, with a shade of brown, red, or grey. Its specific gravity varies. That of Albania, as ascertained by Klaproth, was 1.20; but it was somewhat contaminated with earth. Kirwan, in purer specimens, found the specific gravity to vary from 1.07 to 1.16. Klaproth has lately published an analysis of the asphaltum of Albania. He found it insoluble, both in acids and alkalies, as also in water and alcohol; but soluble in oils, petroleum, and sulphuric ether. Five parts of rectified petroleum dissolved one part of asphaltum without the assistance of heat, and formed a blackish brown solution, which by gentle evaporation left the asphaltum in the state of a black brown shining varnish. The solution in ether was of a pale brown

red colour; and when evaporated, the asphaltum remained in the state of a semifluid substance of a reddish colour, still insoluble in alcohol. A hundred grains of this asphaltum being distilled in a retort, by a heat gradually raised to redness, yielded the following products.

	Grains.
Heavy inflammable air	16
A light brown fluid oil	32
Water slightly tainted with ammonia	6
Charcoal	30
Ashes	16
	100

These ashes consisted chiefly of silica and alumina, with some iron, lime, and manganese. The asphaltum found in Albania is supposed to have constituted the chief ingredient of the Greek fire. The Egyptians are said to have employed this bitumen in embalming. It was called mumia mineralis. The ancients inform us that it was used instead of mortar in building the walls of Babylon. The Arabians still use a solution of it in oil to besmear their horse harness, to preserve it from insects. Buildings are said to be constructed with this pitch; and Peter de Vol mentions, that he examined very old buildings, the stones of which were cemented by means of mineral pitch; and which were still firm and good. Asphaltum is seldom absolutely pure; for when alcohol is digested on it, the colour of the liquid becomes yellow and by gentle evaporation a portion of petroleum is separated. Mineral tar seems to be nothing else than asphaltum, containing a still greater proportion of petroleum. When alcohol is digested on it, a considerable quantity of that oil is taken up; but there remains a black fluid substance like melted pitch, not acted upon by alcohol, and which therefore appears to possess the properties of asphaltum, with the exception of not being solid. By exposure to the air, it is said to assume gradually the state of asphaltum.

ASPHODEL, in botany, a genus of the Hexandria Monogynia class of plants, the flower of which is liliaceous, consisting of a single petal, divided into six segments; and its fruit is a globose-trilocular capsule, containing a number of triangular seeds, gibbous on one side.

According to Martyn, there are three species. The yellow Asphodel is a native of Sicily. Of the white, there are immense tracts of land in Apulia covered with it, for the purpose of feeding sheep. The onion-leaved Asphodel is an annual that grows naturally in France, Spain, and the island of Crete. The yellow and white are pretty ornaments for a flower garden, and cultivated with very little trouble. They may be propagated with seeds, which should be sown soon after they are ripe.

ASPHYXIA, in medicine, a term which signifies want of pulsation, and is used to denote apparent death. Such suspensions of the vital actions are referred by Cullen to apoplexy and syncope. See MEDICINE.

ASPLENIUM, *milt-waste, or spleen-wort,* in botany, a genus of Cryptogamia Filices plants, the fructification of which is arranged in clusters, and disposed in form of straight lines, under the disk of the leaf.

There are, according to Martyn, 47 species; and he observes, that whoever is desirous of cultivating these ferns, must have walls, rocks, or heaps of stones, to set the hardy species in; or pots may be filled with loamy undunged earth, or sand, gravel, and lime rubbish for that purpose, placing them in the shade.

ASS. See EQUUS.

ASSAULT, in law, a violent injury offered to a man's person, being of a higher nature than battery; for it may be committed by offering a blow, or a terrifying speech. In case a person threatens to beat another, or lies in wait to do it, if the other is hindered in his business, and receives loss, it will be an assault, for which an action may be brought, and damages recovered. Not only striking, but thrusting, pushing, casting stones, or throwing drink in the face of any person, are deemed assaults.

In all which cases a man may plead in his justification, the defence of his person or goods, father, mother, wife, master, &c.

ASSAYING, is a term particularly applied to the separation of gold or silver from other metals. In its more extended meaning it is used for the determination of the quantity of any metal whatsoever, in composition with any other metal or mineral.

The assaying of gold or silver is divided into two operations; by the first they are separated from the imperfect metals, or those easily oxyded; by the second they are parted from the metals which resist oxydation by simple exposure to air, and which are therefore called the perfect metals; this second process generally consists in parting gold and silver from each other, as the third

perfect metal, platina, is but seldom found united to them.

The basis of the method of separating gold or silver from the imperfect metals is founded on the facility with which the latter imbibes oxygen; and the process is calculated to accelerate this operation as much as possible; hence the oxide of lead or litharge, is generally considered as the most powerful purifier of the perfect metals, from the ease with which it parts with its oxygen to the imperfect metals united with them; but of late, oxide of manganese has been found superior to it in several instances for this purpose. In the chemical analyses of metals, the oxide of lead is generally preferred for the above purpose; but in the assays, performed by authority, metallic lead is always used, probably from the ease it is supposed to afford in determining the weight of the different ingredients by calculation. The lead in the process first becomes oxyded, then yields some of its oxygen to the other imperfect metals, and afterwards becomes vitrified in conjunction with the other oxides so formed, and carries them off along with it, leaving the perfect metals pure. The above operation is called cupellation, and is performed on a flat round cake of bone ash, compressed within an iron ring, that is named a cupel: this is placed in a vessel called a muffle, which resembles an oven in miniature, that is fixed in a furnace capable of giving a heat sufficient for the fusion of gold, so that its mouth may come in contact with a door at the side, to which it is luted, to separate it from the peel; there are small slits formed in the sides of the muffle to afford a passage for the air.

When the muffle and empty cupels are heated red hot, a little powdered chalk is put on the floor of the muffle to prevent the cupels from adhering to it after the operation. Cupels should be always of size proportionate to the lead to be used, as they cannot absorb a weight of litharge at the utmost more than their own.

The assay of silver is performed in this country on a piece of metal not exceeding thirty-six grains, if the alloy appears considerable; which piece is laminated, and weighed with extreme accuracy in a very sensible balance. It is then wrapped up in the requisite quantity of lead, rolled out into a sheet, which is revived from litharge that it may be free from the silver which lead in general contains naturally.

The silver and lead are put on the cupel when it and the muffle are red hot. The metal immediately melts and begins to send off dense fumes, and a minute stream of red fused matter is seen perpetually flowing from the top of the globule down its sides to the surface of the cupel, where it sinks; the fume consists of lead in vapour, and the red stream of vitrified lead which carries down with it the copper, or other alloy of silver into the cupel. As the cupellation advances the melted button becomes rounder, its surface becomes streaky with large bright points of the fused oxide, which move with increased rapidity; the last portions of the litharge on the surface quickly disappear, shewing the melted metal with bright iridescent colours, which directly after becomes opake, and then suddenly appears brilliant, clean, and white, as if a curtain had been withdrawn from it; at which time the assayers say it lightens. The silver is now left pure, and the cupel is allowed to cool gradually till the globule of silver is fixed, when it is taken out while still hot, and when cold weighed with as much accuracy as at first. The difference between the weight of the globule and that of the silver first put in, shews the quantity of alloy. If the globule is cooled too quickly the outward surface contracts so suddenly as to force out the fluid metal at the centre in arborescent shoots, by which some portion is lost, and the assay spoiled.

In the assays for the mint in this country, two assays are always made of the same mass of metal, and no sensible difference between the weights of the buttons is allowed to pass in scales that turn with the $\frac{1}{1200}$ part of a grain troy. If they differ the assay is repeated.

The process is considered as well performed when the button adheres but slightly to the cupel; when its shape is very considerably globular above and below, and not flattened at the margin; when it is quite clear and brilliant, and not folded or spotted with any remaining litharge; and, especially, when the surface is disposed in minute scales, the effect of a hasty crystallization, which gives it a play of light very different from that of a perfectly even surface of a white metal. The scales are of a pentagonal form, slightly depressed at the centre. When any alloy remains in the silver, the surface appears under the microscope smooth as if varnished, and scarcely at all scaley in texture.

In the common assays of plate, either gold or silver, copper is the alloy usually

met with; if the fine metal be nearly pure, the cupel round the bottom is only stained yellow by the litharge; if copper is contained, it leaves a brown stain. The other metals, except bismuth, scarcely penetrate the substance of the cupel, but remain on the edges of its cavity in the form of coloured scoriæ; of which iron is black, tin grey, and zinc a dull yellow.

The management of the fire is a point of great consequence in cupellation. When silver is kept in fusion in a very high heat, a portion of it is volatilized; as Mr. Tillet found that a button of pure silver, kept in a very high heat, lost a twentieth part of its weight; which loss would cause a great error in assaying. On the other hand, when the fire is too slack, the litharge is not absorbed by the cupel, but lies on the surface as a red scoria. The heat is known to be too great when the cupel can scarcely be distinguished from the muffle, and the ascending fume can scarcely be seen for the dazzling heat. Towards the end of the operation the fire should be gradually increased, for in proportion as the lead is abstracted from the alloy, it becomes less easy of fusion; and at last an heat fully equal to the melting of pure silver is required.

As the cupellation requires a free access of air as well as an high degree of heat, the stopper of the muffle is always removed as soon as the metal is put into the hot cupel, to allow a current of air to pass through the muffle: but to prevent this from cooling the muffle too fast, several round pieces of charcoal are heaped up in front of the muffle, on an iron plate placed there to hold them, which burn with sufficient force to heat the air as it passes to the cupels. The furnace should be made so that the heat of the fuel within may be readily increased or diminished, but at the same time so that it can be kept up with steadiness.

The time taken up in making one assay of silver is generally from 15 to 25 minutes. The proportioning of the lead to the supposed alloy in the silver to be assayed, is of great importance; if too little is employed some of the alloy will remain in the mass; but if too much is used some of the silver will be wasted; for Mr. Tillet has found that when the proper quantity of lead is used it carries down a portion of the silver into the cupel, which he has ascertained by accurate experiments to amount to $\frac{1}{128}$ of the lead in the cupel; whereas the natural admixture of silver in lead is only $\frac{1}{1152}$. But when an excess of lead is employed for cupellation, this loss of silver is somewhat greater, though it does not increase in the ratio of the excess of lead, for ten parts of lead to a given alloy will not carry down twice as much silver as five parts, though the difference of loss will be very sensible. When the litharge carried into the cupel is reduced to reguline lead, on being cupelled a second time it will yield a button of silver fully equal to the loss of this metal in the first assay. In all these reductions the silver appears equally distributed through the lead, for Mr. Tillet found that separate globules of the lead spurted out by accident upon an empty cupel in the muffle, each left a minute atom of silver lying upon the spot where the globules had scorified.

Bismuth will serve the same purpose as lead in cupellation; but besides being dearer, it is found to carry down with it into the cupel somewhat more of the silver than the same quantity of lead does.

To estimate the quantity of alloy in silver, the ancient assayers used touch-needles, or small slips of silver, alloyed with known proportions of copper, in a regularly increasing series from the least to the greatest proportion ever used. The silver to be assayed was compared with these, and its alloy estimated by that of the needle to which it shewed the closest resemblance. But an experienced assayer is at the present time able to judge of the alloy with sufficient exactness, by the ease or difficulty with which the silver is cut, by the colour and grain of a fresh cut surface, the malleability, the change of surface when made red hot, and the general appearance.

The assay of gold is more complicated than that of silver. The baser metals may be separated from it by cupellation in the same manner as from silver, except copper, which has so strong an affinity for gold that it can scarcely be overcome by this method, unless silver is first combined with the mass; and this makes the second operation necessary, mentioned before, namely the parting of the gold from the silver.

The process of parting is performed by the aquafortis of commerce, which dissolves the silver and leaves the gold untouched. But in this operation it is found that when the gold exceeds a certain proportion in the mixture, it so much protects the silver from the acid, as more or less to prevent its action. Therefore when the gold is in excess it becomes necessary to add so much silver as to give this metal the predominance. The proportion of silver generally

used is three parts to one of the gold, from whence the process obtained the name of quartation. Several good assayers think two parts of silver are sufficient. More than three parts also may be used, but then it will protract the process needlessly.

Though when copper also as well as silver is present, the parting may be proceeded to, as this metal is likewise soluble in aquafortis; yet it is found to have some advantages to cupel the mixture first with lead; and likewise even when no copper is combined with the gold.

The cupellation of gold is thus conducted; the portion of the alloy of silver being estimated by touch-needles, as much silver is added as will make the entire quantity of this metal about thrice the weight of pure gold.

The proportion of lead to the alloy of copper or other base metal, is nearly the same as for silver, which will be shewn particularly in the annexed table. The heat necessary in the process is greater than for silver, and may be used with freedom, as none of the gold is lost by volatilization. The lighting of the fused globule of gold takes place as in silver. The button is cooled, taken out and weighed, then hammered flat and annealed, and afterwards laminated between steel rollers to a thin plate about the substance of a wafer, again heated to redness, and then coiled up into a spiral roll. The button of gold when it lightens still retains a minute portion of lead; this may be got rid of by its being kept a little time in fusion in a clean vessel. The lead entirely disappears after parting.

The spiral roll is called a cornet, and when prepared is put into a glass matrass, shaped like a pear, in order to part the silver from it, and about thrice its weight of pure nitric acid poured on it moderately diluted (so as to be about 1.25 specific gravity). The glass is set on a sand bath, or over charcoal to boil. When warm the acid dissolves the silver; as long as it continues to act, the cornet is studded with minute bubbles; when these discontinue, or are united in one large one, it is a sign that the acid has ceased to operate. About twenty minutes are required for this process.

The cornet is now corroded throughout, having lost its silver; it retains the same form, but is very slender and brittle. It is of importance to the accuracy of the assay that it should not be broken. The hot acid solution of silver is then poured off with great care, and fresh acid rather stronger is added to clear away all remains of the silver, and boiled as before, but only for five or six minutes. It is then decanted and added to the first solution, and the parting glass is filled with hot distilled water, to wash off all remains of the solution. A small crucible is to be inverted over the glass while it is full of water, the latter is then nimbly turned, and the cornet falls gently into the crucible through the water; which being poured off, the crucible is dried and heated to redness under a muffle, when the cornet shrinks extremely in every direction, becomes firm, and when cooled regains its metallic lustre, and is soft and flexible. It is then most accurately weighed and the process is finished.

The final weight of the gold cornet indicates the absolute quantity of this metal in the assayed sample. The difference between the weight of the button after cupellation (deducting the silver added) and the first sample, is the weight of the copper, or other base metal in the gold; and the difference between the gold cornet, together with the silver added, and the button after cupellation, is the quantity of silver with which the gold was alloyed.

The silver is usually recovered from the solution left after parting, by immersing in it plates of bright copper, which dissolve and precipitate the silver in its metallic form.

Touch-needles for gold are formed in the same manner as for silver, but more of them are required, as the various combinations of three metals are to be examined by them in this case. Four sets of them are usually employed; one in which pure silver is used for the alloy, another in which the alloy is two parts silver and one of copper, a third with two parts copper and one of silver, and a fourth of copper only. In trials with these needles nitric acid is of singular service, a drop of it is let fall on the streak of metal on the touch-stone; in eight or ten seconds it is washed off and the effect observed. If the streak preserves its golden brilliance unaltered, the metal is judged to be of a certain degree of fineness. If it looks red, dull, and coppery, it is less fine; but if the streak is almost entirely effaced, it contains very little gold.

A peculiar set of weights are used for assaying.

The quantity of metal taken for an assay is always very small; in this country generally from 18 to 36 grains troy for silver, and from 6 to 12 grains for gold. This is

the integer, and whatever be its real weight it is denominated the assay pound. This imaginary pound is then subdivided into aliquot parts, but differing according to the metal. The silver assay pound is subdivided into 12 imaginary ounces, each ounce into 20 pennyweights; and, for assaying, these again into halves.

The following is the table of the proportions of lead required to different alloys of copper. In the three first columns is shewn the absolute increase of the quantity of lead in alloys of decreasing fineness. In the three last columns will be seen the gradual diminution of the protecting power of fine metal against scorification, in proportion to the increase of alloy, shewn by the decreasing quantity of lead required for the same weight of copper, under different mixtures.

Silver.	Copper.	Lead.	Ratio of Inc.	Copper.	Silver.	Lead.
23 with	1 requires	96 =	4 × 24 and hence	1 with	23 requires	96
22	2	144 =	6 × 24	1	11	72
20	4	192 =	8 × 24	1	5	48
18	6	240 =	10 × 24	1	3	40
16	8	288 =	12 × 24	1	2	36
14	10	336 =	14 × 24	1	$1\frac{2}{5}$	33
12	12	384 =	16 × 24	1	1	32
10	14	432 =	18 × 24	1	$\frac{5}{7}$	30 ×
8	16	480 =	20 × 24	1	$\frac{1}{2}$	30
6	18	528 =	22 × 24	1	$\frac{1}{3}$	29 ×
4	20	576 =	24 × 24	1	$\frac{1}{5}$	28 ×
2	22	624 =	26 × 24	1	$\frac{1}{11}$	28 ×

It should be remarked, however, that many assayers, of good authority, use proportions of lead to alloy considerably different from the above table; and that the whole numbers here given may be considered as rather high in proportion to the quantity of lead.

The proportions of lead for gold assaying are nearly the same as for silver.

Assays of alloys with platina are conducted nearly in the same manner as for the mixtures of silver and gold. Silver is seldom alloyed with it; but gold is more frequently; and is known by the much greater heat it requires in the fusion; by the edges of the button appearing thicker and rounder than in common assays of gold; by its colour being duller and tending to yellow; and its being entirely crystallised on it surface.

The action of nitrous acid on the alloys of platina is very remarkable. By itself, platina is as insoluble in this acid as gold, and a mixture of these two metals equally resists its action; but when silver enters into the mixture in the proportion of $2\frac{1}{2}$, or three times the weight of the gold and platina, and when the platina is not above a tenth of the gold, the platina is totally soluble in nitrous acid, together with the silver, and the gold alone remains untouched.

When the gold mixed with platina is to be freed from it in the above manner, it must be laminated very thin; a weak acid is first added and boiled for some time. If the platina is above two per cent. of the gold, the acid assumes a straw colour, which deepens in proportion to the platina, and at the same time the cornets assume a brownish green. A stronger acid is then added, and boiled three times successively, to detach the last portions of platina which are separated with difficulty. By laminating very fine, using the acid liberally, and long boiling, all the platina may be separated in one operation, when it does not exceed a tenth of the gold: and above that proportion the colour of the gold is so much debased, and the appearances on the cupel so striking, that fraud can hardly escape an experienced eye. Parting might be used even when the platina was more than a tenth of the gold, but then more silver must be added, which would render the cornet so very thin after the action of the acid that it could hardly be annealed without breaking.

When alloys of silver alone with platina are treated with nitrous acid, the silver dissolves as usual, but the liquor soon becomes muddy with a very fine bulky black precipitate, which continues increasing till all the silver is dissolved, and which is found to be entirely platina when collected. A part of the platina, however, remains in the solution, for on adding muriatic acid to the liquor separated from the black precipitate, white luna cornea falls down, after which carbonate of potash will throw down a green

coagulum, which is oxide of platina. The above effects of nitrous acid will therefore detect an alloy of silver and platina.

ASSETS, are goods or property in the hands of a person with which he is enabled to discharge an obligation imposed upon him by another; they may be either real or personal. Where a person holds lands in fee-simple, and dies seized thereof, those lands, when they come to the heir, are called assets. So far as obligations are left on the part of the deceased to be fulfilled, they are called assets real. When such assets fall into the management of executors, they are called assets intermaines. When the property left consists of goods, money, or personal property, they are called assets personal.

ASSIENTO, a Spanish word, signifying a farm, in commerce, is used for a bargain between the king of Spain and other powers, for importing negroes into the Spanish dominions, in America, and particularly in Buenos Ayres. The first assiento was made by the French Guinea Company; and, by the treaty of Utrecht, transferred to the English, who were to furnish four thousand eight hundred negroes annually.

ASSIGN, in common law, a person to whom a thing is assigned or made over.

ASSIGNEE, in law, a person appointed by another to do an act, transact some business, or enjoy a particular commodity. Assignees may be by deed or by law; by deed, where the lessee of a farm assigns the same to another; by law, where the law makes an assignee, without any appointment of the person entitled, as an executor is assignee in law to the testator, and an administrator to an intestate. But when there is assignee by deed, the assignee in law is not allowed.

ASSIGNING, in a general sense, is the setting over a right to another; and in a special sense is used to set forth and point at, as to assign an error, to assign false judgment, to assign waste; in which cases it must be shewn wherein the error is committed, where and how the judgment is unjust, and where the waste is committed.

ASSIGNMENT, is a transfer, or making over to another, of the right one has in any estate; but it is usually applied to an estate for life or years. And it differs in a lease only in this; that by a lease one grants an interest less than his own, reserving to himself a reversion; in assignment he parts with the whole property, and the assignee stands to all intents and purposes in the place of the assignor. 2 Black. 326.

Assignment, in a military sense, signifies a public document, by which colonels of regiments become entitled to certain allowances for the clothing of their several corps.

ASSIMILATION, in animal economy, is that process by which the different ingredients of the blood are made parts of the various organs of the body. Over the nature of assimilation, says Dr. Thomson, the thickest darkness hangs, there is no key to explain it, nothing to lead us to the knowledge of the instruments employed. Facts, however, put the existence of the process beyond the reach of doubt. The healing of every fractured bone, and of every wound of the body, is a proof of its existence, and an instance of its action. Every organ employed in assimilation has a peculiar office, and it always performs this office whenever it has materials to act upon, even when the performance of it is contrary to the interest of the animal. Thus the stomach always converts the food into chyme, even when the food is of such a nature that the process of digestion is retarded rather than promoted by the change. If warm milk be taken into the stomach, it is decomposed by that organ, and converted into chyme, yet the milk was more nearly assimilated to the animal before the action of the stomach, than after it. The same thing occurs when we eat animal food. If a substance be introduced into an organ employed in assimilation, that has already undergone the change which that organ is fitted to produce, it is not acted upon by that organ, but passes on unaltered to the next assimilating organ. Thus it is the office of the intestines to convert chyme into chyle; and whenever chyme is introduced into the intestines, they perform their office, and produce the usual change; but if chyle itself be introduced, it is absorbed by the lacteals without alteration. Again, the business of the blood-vessels, as assimilating organs, is to convert chyle into blood; chyle therefore cannot be introduced into the arteries without undergoing that change; but blood may be introduced from another animal without any injury, and consequently without undergoing any change. Though the different assimilating organs have the power of changing certain substances into others, and of throwing out the useless ingredients, yet this power is not absolute, even when the substances on which they act are proper for undergoing the change which

the organs produce. The stomach converts food into chyme, and the intestines change chyme into chyle; and the substances that have not been converted into chyle are thrown out of the body. If there should be present in the stomach and intestines any substance which, though incapable of undergoing these changes, at least by the action of the stomach and intestines yet has a strong affinity either for the whole chyme and chyle, or for some particular part of it; and no affinity for the substances which are thrown out, that substance passes with the chyle, and in many cases continues to remain chemically combined with the substance to which it is united in the stomach, even after the substance has been completely assimilated, and made a part of the body of the animal. Thus there is an affinity between the colouring matter of madder and phosphate of lime; and when madder is taken into the stomach, it combines with the phosphate of lime of the food, passes with it through the lacteals and blood vessels, and is deposited with it in the bones. In the same way musk, indigo, &c. when taken into the stomach make their way into many of the secretions. These facts prove that assimilation is a chemical process; that all the changes are produced according to the laws of chemistry; and Dr. Thomson adds, that we can derange the regularity of the process by introducing substances whose mutual affinities are too strong for the organs to overcome. See PHYSIOLOGY.

ASSISE, in old law-books, is defined to be an assembly of knights and other substantial men, with the justice, in a certain place, and at a certain time; but the word, in its present acceptation, is used for the court, place, or time, when and where the writs and processes, whether civil or criminal, are decided by judges and jury. In this signification, assise is either general, when judges make their respective circuits, with commission to take all assise; or special, where a commission is granted to particular persons for taking an assise upon one or two disseisins only. By magna charta, justices shall be sent through every county, once a year, who, with the knights of the several shires, shall take assise of novel disseisin; and as to the general assise, all the counties of England are divided into six circuits, and two judges are assigned by the king's commission to every circuit, who now hold the assises twice a year, in every county, except Middlesex, where the courts of record sit, and the counties palatine. These judges have five several commissions. 1. Of oyer and terminer, by which they are empowered to try treasons, felonies, &c. 2. Of gaol-delivery, which empowers them to try every prisoner in gaol, for whatever offence he be committed. 3. Of assise, which gives them power to do right upon writs brought by persons wrongfully thrust out of their lands and possessions. 4. Of nisi-prius, by which civil causes come to issue in the courts above, are tried in the vacation by a jury of twelve men, in the county where the cause of action arises. 5. A commission of the peace in every county of the circuit; and all justices of peace of the county, and sheriffs, are to attend upon the judges, otherwise they shall be fined.

ASSOCIATION *of ideas* is where two or more ideas constantly and immediately follow one another, so that the one shall almost infallibly produce the other, whether there be any natural relation between them or not.

When our ideas have a natural correspondence and connection one with another, it is the office and excellency of our reason to trace these, and hold them together, in that union and correspondence, which is founded in their peculiar beings. But when there is no affinity between them, nor any cause to be assigned for their accompanying each other, but what is owing to mere accident or custom; this unnatural association becomes a great imperfection, and is, generally speaking, a main cause of error, or wrong deductions in reasoning.

To this wrong association of ideas, made in our minds by custom, Mr. Locke attributes most of the sympathies and antipathies observable in men, which work as strongly, and produce as regular effects, as if they were natural, though they at first had no other original than the accidental connection of two ideas, which either by the strength of the first impression, or future indulgence, are so united, that they ever after keep company together in that man's mind, as if they were but one idea.

The ideas of goblins and spirits have really no more to do with darkness than light; yet let but these be inculcated often in the mind of a child, and there raised together, possibly he shall never be able to separate them again as long as he lives, but darkness shall ever afterwards bring with it these frightful ideas.

So if a man receive an injury from another, and think on the man and that action

over and over, by ruminating on them strongly, he so cements these two ideas together, that he makes them almost one; he never thinks on the man, but the place and displeasure he suffered come into his mind with it, so that he scarce distinguishes them, but has as much aversion for the one as the other. Thus hatreds are often begotten from slight and almost innocent occasions, and quarrels are propagated and continued in the world.

Nor is its influence on the intellectual habits less powerful, though less observed. Let the ideas of being and matter be strongly joined, either by education or much thought, whilst these are still combined in the mind, what notions, what reasonings, will there be about separate spirits? Let custom, from the very childhood, have joined figure and shape to the idea of God; and what absurdities will that mind be liable to about the deity? Some such wrongs and unnatural associations of ideas will be found to establish the irreconcileable opposition between different sects of philosophy and religion; for we cannot suppose that every one of their followers will impose wilfully on himself, and knowingly refuse truth offered by plain reason. Some independent ideas, of no alliance to one another, are, by custom, education, and the constant din of their party, so coupled in their minds, that they always appear there together, and they can no more separate them in their thoughts, than if they were but one idea; and they operate as if they were so.

ASSONIA, in botany, a genus of the Monadelphia Dodecandria plants, and of the natural order of Columniferæ Malvaceæ of Jussieu. The essential character is, calyx double, outer one-leafed or three-leaved, inner one-leafed; corol five-petalled, without any tube, affixed to the pitcher of stamens; filament connected in form of a pitcher, with petal-shaped straps between them; style one or five; capsule five-celled; seeds not winged. There are eleven species.

ASSUMPSIT, a voluntary or verbal promise, whereby a person assumes, or takes upon him to perform or pay any thing to another. When any person becomes legally indebted to another for goods sold, the law implies a promise that he will pay his debt; and if he do not pay it, the writ *indebitatus assumpsit* lies against him; and will lie for goods sold and delivered to a stranger, or third person, at the request of the defendant; but the price agreed on must be proved, otherwise that action does not lie.

ASSURANCE, or INSURANCE, an engagement by which a person is indemnified from the loss he would sustain by the happening of a particular event; as by the capture or wreck of a ship at sea, or the destruction of goods by fire. Projects have at different times been formed for assuring against frauds and robbery, against losses by servants, the death of cattle, and almost every event by which unforeseen loss may arise; but such schemes have always failed, and the business of assurance is now generally confined to the risks of the sea, assurance against fire, and the assurance of lives.

This mode of securing merchants against the dangers of navigation is said to have originated in the time of the Emperor Claudius, but during the subsequent decline of commerce it probably fell into disuse. The sea laws of Oleron, as far back as the year 1194, treat of it, and it was soon after practised in Great Britain. The statute of 43 of Queen Elizabeth, cap. 12, states, that it has been time out of mind a usage among merchants, both of this country and of foreign nations, to make assurances on their goods, merchandize, and ships, going to foreign parts; for the better regulation of which, with respect to disputes which arose on policies of assurance, commissioners were appointed, who were to meet weekly at the Office of Insurance on the west side of the Royal Exchange, to determine all causes concerning policies of assurance in a summary way, but reserving a right of appeal to the Court of Chancery. This shows that such assurances were in common practice, and had become of considerable importance.

Assurance against the dangers of the sea appears to have been in use in England somewhat earlier than in many commercial cities on the continent, as the policies of assurance of Antwerp, and also of other places in the Low Countries, contained a clause that they should be construed in all things according to the custom of Lombard Street in London. In the year 1627, Charles I. granted a monopoly for 31 years of the right of making all assurances on ships or goods in the City of London.

In 1712, several attempts were made to establish offices for assurance on marriages, births, &c. which all failed. In 1719 the Royal Exchange Assurance and London Assurance companies were formed, and in the following year obtained charters of in-

corporation, by which they were distinguished from a variety of schemes for every species of assurance then projected, most of which were of very short duration. The two companies just mentioned are the only corporate bodies authorized to make sea assurances, the principal part of this business, in London, being transacted by four or five hundred individual assurers or underwriters, who assemble daily for this purpose at Lloyd's coffee-house, formerly in Lombard Street, but now kept over the Royal Exchange. The premiums which they require are regulated by the length or danger of the voyage, the condition of the vessel, the time of the year, and the country being at peace or war; of course they vary considerably at different periods. Thus, in time of peace, an assurance may be made from London to the East Indies, on the Company's regular ships, at 6 or 7 guineas *per cent.* out and home, which in time of war is advanced to 12 guineas *per cent.*

At Hamburgh there are about thirty companies for making sea assurances, two or three in Bremen, some in Lubeck and Trieste, and one even in Berlin and Breslaw; there is also a chartered marine assurance company at Stockholm, and one at Copenhagen; their capitals, however, are not very considerable, and they never venture large sums on one risk. There are private underwriters at Stockholm, Gottenburg, and Copenhagen, who assure moderate risks. At New York, Philadelphia, and many other principal towns in the American states, assurance companies have been established; and in the East Indies there are no less than five assurance offices at Calcutta, four or five at Madras, and one at Bombay; but their business is not very extensive, being principally confined to the assurance of the coasting trade in India, and the trade from India to China.

Assurance against loss or damage from fire is a practice, the utility of which has become so generally evident, that it has of late years increased considerably. Dr. A. Smith, in 1775, supposed, that taking the whole kingdom at an average, 19 houses in 20, or perhaps 99 in 100, were not insured from fire. But the case is now very different, as there is scarcely any considerable town in England which has not in it either an office of its own, or agents from the London offices for effecting assurances.

All kinds of property liable to be destroyed by fire, as houses and buildings of every description, household furniture, apparel, merchandize, utensils and stock in trade, farming stock, and ships in harbour or while building, may be assured at a fixed rate *per cent.*; but all kind of writings, accounts, notes, money, and gunpowder, are generally excepted.

The offices distinguish the different risks of assurance against fire in the following manner:

Common assurances are assurances on all manner of buildings, having the walls of brick or stone, and covered with slate, tile, or metal, wherein no hazardous trades are carried on, nor any hazardous goods deposited; and on goods and merchandizes, not hazardous, in such buildings. The premium on such assurances is 2*s. per cent. per annum.*

Hazardous assurances are assurances on timber or plaster buildings, covered with slate, tile, or metal, wherein no hazardous trades are carried on, nor any hazardous goods deposited; and on goods or merchandizes, not hazardous, in such timber or plaster buildings; and also on hazardous trades, such as cabinet and coach makers, carpenters, coopers, bread and biscuit bakers, ship and tallow chandlers, soap-makers, innholders, sail-makers, maltsters, and stable-keepers, carried on in brick or stone buildings, covered with slate, tile, or metal; and on hazardous goods, such as hemp, flax, rosin, pitch, tar, and turpentine, deposited in such buildings; the stock in trade of apothecaries, also on ships, and all manner of water-craft, in harbour, in dock, or while building, and on thatched buildings, which have not a chimney, and which do not adjoin to any building having a chimney. The charge for this class of assurance is 3*s. per cent. per annum.*

Doubly-hazardous assurances are assurances on any of the aforesaid hazardous trades carried on, or hazardous goods deposited, in timber or plaster buildings, covered with slate, tile, or metal; on glass, china, and earthen ware; also on thatched buildings or goods therein, (except as in the preceding class) and on saltpetre, with the buildings containing the same. Such assurances are usually charged 5*s. per cent. per annum.*

Assurances on jewels, plate, medals, watches, prints not in trade, pictures, drawings, and statuary work; also assurances to cotton-spinners and all other manufacturers of raw cotton; to distillers, flambeaux and varnish makers; to oil, spermacæti, wax, or sugar refiners; to boat-builders, cork-cutters, japanners, colourmen, rope-makers

sea-biscuit bakers, and tallow-melters; or on chymists' laboratories; mills, or any other assurances more than ordinarily hazardous, by reason of the trade, nature of the goods, narrowness of the place, by the use of kilns or stoves in the process of any manufactory, or other dangerous circumstances, are made by special agreement, at a premium proportionate to the risk.

Assurances on building and goods are deemed distinct and separate adventures, so that the premium on goods is not advanced by reason of any assurance on the building wherein the goods are kept, nor the premium on the building by reason of any assurance on the goods; and any number of dwelling-houses and out-houses, together with the goods therein, may be assured in one policy, provided the sum to be assured on each is particularly mentioned.

In 1782 a duty of 1*s.* 6*d.* was imposed on every 100*l.* assured from loss by fire, which was increased in 1797 to 2*s. per cent.*, and in 1804 to 2*s.* 6*d. per cent.*, the annual duty now payable. From the produce of this duty, an estimate has been formed of the total amount of property assured from fire in Great Britain, which appears to have been nearly as follows:

In 1785............£	125,000,000
1789............	142,000,000
1793............	167,000,000
1797............	184,000,000
1801............	223,000,000
1806............	260,000,000

In the year last mentioned there were 11 offices for assurance against fire in London, and 21 in other parts of Great Britain.

ASSURANCE *on lives*, secures a sum of money to be received on the extinction of any life in consideration of an annual premium paid to the assurer during the continuance of the life. Such assurances are made for a given term of years, or during the whole continuance of the life, or the joint continuance of two lives; and as they are of great utility to persons having life incomes or life estates, and as collateral securities in many cases for money borrowed, this species of assurance, as it has become more generally understood, has likewise greatly increased. In 1790 there were only three societies in London which made assurances on lives; in 1807 there were ten offices for transacting such business. These offices all require nearly the same annual premiums, of which the following are a specimen.

Age.	1 Year.			7 Years.			Whole Life.		
	£.	s.	d.	£.	s.	d.	£.	s.	d.
10......	0	17	9......	1	1	5......	1	17	11
15......	0	17	11......	1	2	11......	1	18	7
20......	1	7	3......	1	9	5......	2	3	7
25......	1	10	7......	1	12	1......	2	8	1
30......	1	13	3......	1	14	11......	2	13	5
35......	1	16	4......	1	18	10......	2	19	8
40......	2	0	8......	2	4	1......	3	7	11
45......	2	6	8......	2	10	10......	3	17	11
50......	2	15	1......	3	0	8......	4	10	10
55......	3	5	0......	3	12	0......	5	6	4
60......	3	18	1......	4	7	1......	6	7	4
65......	4	15	2......	5	10	10......	7	16	9
67......	5	5	6......	6	5	2......	8	12	1

These rates are computed from the probabilities of life, according to the Northampton bills of mortality; the mode of calculating them is explained by Dr. Price in his Treatise on Reversionary Payments, and by Mr. Morgan in a very useful work entitled "The Doctrine of Annuities and Assurances on Lives and Survivorships stated and explained."

Persons who are engaged in military or naval service, or who have not had the small-pox, or are subject to the gout, are charged an additional premium, supposed to be adequate to the additional risk.

Policies of assurance on lives generally contain clauses to the following effect.

Conditions of assurance made by persons on their own lives.—The assurance to be void if the person whose life is assured shall depart beyond the limits of Europe, shall die upon the seas (except in his Majesty's packets passing between Great Britain and Ireland); or shall enter into or engage in any military or naval service whatever, without the previous consent of the assurers; or shall die by suicide, duelling, or the hand of justice; or shall not be, at the time the assurance is made, in good health.

Conditions of assurance made by persons on the lives of others.—The assurance to be void if the person whose life is assured shall depart beyond the limits of Europe, shall die upon the seas (except in his Majesty's packets passing between Great Britain and Ireland); or shall enter into or engage in any military or naval service whatever, without the previous consent of the assurers; or shall not be, at the time the assurance is made, in good health.

Any person making an assurance on the life of another, must be interested therein, agreeable to Act of 14th of George III.

chap. 48, which prohibits wagering, or speculative insurances.

ASTER, in botany, *starwort*. Class, Syngenesia Polygamia Superflua. Gen. char. cal. common, imbricate, the inner scales prominent a little at the end, lower ones spreading; cor. compound, radiate; corollules hermaphrodite, numerous in the disk; females ligulate, more than 10 in the ray; proper of the hermaphrodite, funnel-shaped, with a five-cleft spreading border: of the female ligulate, lanceolate, three-toothed, at length rolling back; stam. hermaphrodite; filaments five; capillary very short; anthers cylindric, tubulous; pist. germ oblong; style filiform, the length of the stamens; stigma bifid, spreading; females, germ and style the same; stigmas two, oblong revolute; per. none; calyx scarcely changed; seeds solitary, oblong, ovate; down capillary; rec. naked, flattish. The species from the Cape, together with those not producing seeds in England, are propagated by cuttings, any time during the summer. These should be planted in small pots filled with light earth, and plunged into an old hot-bed, where, if they are shaded from the sun, and gently watered, they will put out roots in six weeks, when they may be placed in the open air; and in about a month afterwards they should be separated, each in a small pot, and filled with light sandy earth. In October they must be removed into the green house, and placed where they may enjoy as much free air as possible; but be secured from frosts or damps; so that they are much easier preserved in a glass-case, where they will have more light and air than in a green-house; but they must not be placed in a stove, for artificial heat will soon destroy the plants. The North American species, which make at least three-fifths of the genus, together with the Alpine and Italian asters, are easily propagated by parting the roots in autumn; they are most of them hardy, and will thrive in almost any soil and situation; for these reasons, and because they adorn the latter season with the abundance and variety of their specious flowers, they are valuable plants, especially among shrubs, and in large ornamental plantations, properly mixed with golden rods, and other perennial, autumnal, hardy plants. The sorts most cultivated, are the grandiflorus, linifolius, linarifolius, tenuifolius, ericoides, dumosus, serotinus, alpinus, novæ angliæ, and puniceus or altissimus. Some of the species prefer a shady situation and moist soil. They are apt to spread very much at the roots, so as to be troublesome, and the seeds of some are blown about and come up like weeds. The Italian starwort has not been so much cultivated in England, since the great variety of American species has been introduced, though it is by no means inferior to the best of them. It is propagated by parting the roots soon after the plant is out of flower. The roots should not be removed oftener than every third year. Catesby's starwort, not multiplying fast by its roots, may be propagated in plenty by cuttings from the young shoots in May, which, if planted in light earth, and shaded from the sun, will flower the same year. When the annual starwort is once introduced, the seeds will scatter, and the plants come up without care. The China aster, being an annual plant, is propagated by seeds, which must be sown in the spring, on a warm border, or rather on a gentle hot-bed, just to bring up the plants.

ASTERIAS, in natural history, *starfish*, a genus of worms, of the order Mollusca. Body depressed, covered with a coriaceous crust, muricate, with tentacula, and grooved beneath; mouth central, five-rayed. There are more than 40 species, all inhabitants of the sea, and are marked with a rough, white, stony spot above: they easily renew parts which have been lost by violence, and fix themselves to the bottom by swimming on the back and bending the rays. There are three divisions; *viz.* A. lunate; B. stellate; and C. radiate. A. pulvillus is lubricous, with an entire simple margin, and is found in the North seas; body above convex, covered with a smooth sanguineous skin, transversely striate, beset towards the margin with soft, obtuse, white spines about the size of a millet seed, and divided into 10 arcæ; the margin not articulate, but rough in the angles, with about 10 acute papillæ; beneath concave, smooth, whitish, with a rosy tinge, and hollowed by five grooves, each side covered with horizontal batons: it tinges warm water with a tawny colour. A. caput medusæ has five divided and subdivided rays; the disk and rays granulate; mouth depressed. This is a most curious animal, and inhabits the northern seas: the five rays dividing into two smaller ones, and each of these dividing again into two others; which mode of regular subdivision is continued to a vast extent, gradually decreasing in size, till at length the ramifica-

tions amount to many thousands, forming a beautiful net-work. Its colour is sometimes pale or reddish white, sometimes brown.

ASTERISM, in astronomy, the same with constellation. See CONSTELLATION.

ASTEROIDS, in astronomy, a name given by Dr. Herschell to the new planets, Ceres, Juno, Pallas, and Vesta, lately discovered; and which he defines as celestial bodies, which move in orbits either of little or of considerable eccentricity round the sun, the plane of which may be inclined to the ecliptic in any angle whatsoever. This motion may be direct or retrograde; and they may or may not have considerable atmospheres, very small comas, disks, or nuclei. According to the definitions which he premises, planets are celestial bodies of a considerable size and small eccentricity of orbit, moving in planes that do not deviate many degrees from that of the earth, in a direct course, and in orbits at considerable distances from each other, with atmospheres of considerable extent; but bearing hardly any sensible proportion to their diameters, and having satellites or rings: and comets are very small celestial bodies, moving in directions wholly undetermined, and in very eccentric or apparently parabolic orbits, situated in every variety of position, and having very extensive atmospheres. Dr. Herschell having compared the newly discovered stars by the criteria introduced in the above definitions, maintains, that they differ in so many respects from both planets and comets, as to warrant his not referring them to either of these two classes.

ASTHMA, in medicine, a painful, difficult, and laborious respiration. See MEDICINE.

ASTRÆA, in astronomy, the same with Virgo. See VIRGO.

ASTRAGAL, in architecture, a little round moulding, in form of a ring, serving as an ornament at the tops and bottoms of columns. See ARCHITECTURE.

ASTRAGAL, in gunnery, a round moulding encompassing a cannon, about half a foot from its mouth.

ASTRAGALUS, *milk-vetch*, in botany, a genus of the Diadelphia Decandria class of plants, with a papilionaceous flower, and bilocular-podded fruit, containing kidney-like seeds. There are upwards of 60 species; all of which may be raised from seeds. They are in general hardy, and require no other care, but to draw the plants out when they come up too thick, leaving them at least eighteen inches asunder.

ASTRAGALUS, in anatomy, called also the *talus*, is the superior and first bone of the foot, according to its natural situation and connection with the leg, being articulated with the tibia and fibula, and with the calcaneum; having its head formed for the articulation with the os naviculare.

ASTRAL, something belonging to, or connected with the stars: thus, astral year is the same with siderial year.

ASTRANTIA, *black master-wort*, in botany, a genus of umbelliferous plants, belonging to the Pentandria Digynia class of Linnæus, the flower of which is rosaceous, and collected into a sort of head; and its fruit is oval, obtuse, coronated, and striated.

ASTROLABE, an instrument for taking the altitude of the sun or stars at sea, being a large brass ring, the limb of which, or a convenient part thereof, is divided into degrees and minutes, with a moveable index, which turns upon the centre, and turns two sights: at the zenith is a ring to hang it by in time of observation, when you need only turn the index to the sun, that the rays may pass freely through both sights, and the edge of the index cuts the altitude upon the divided limb. This instrument, though not much in use now, if well made, and of great weight, that it may hang the steadier, is as good as most instruments that are used at sea for taking altitudes, especially between the tropics, when the sun comes near the zenith, and in calm weather.

ASTROLOGY, a conjectural and truly absurd science, which teaches to judge of the effects and influences of the stars, and to foretel future events by the situation and different aspects of the heavenly bodies. It may be divided into two branches, natural and judiciary; the former being the prediction of natural effects, as the changes of weather, winds, storms, hurricanes, thunder, floods, earthquakes, &c. and the latter, that which pretends to foretel moral events, or such as have a dependance on the freedom of the will.

ASTRONIUM, in botany, a genus of the Dioecia Pentandria class and order of plants. The essential character is, male, calyx five-leaved; corol five-petalled. Female, calyx five-leaved; corol five-petalled; styles three, and one seed. There is but one species, the A. graveolens, an upright

tree, from 12 to 30 feet in height, abounding every where in a slightly glutinous terebinthine juice. After the fruits in the female, and the flowers in the male plant have fallen off, new branches are put forth. The flowers are small and red, the calyxes are expanded into stars, nearly an inch in diameter. It is native in the woods about Carthagena in New Spain.

ASTRONOMY is the science which treats of the motions, periods, eclipses, magnitudes, &c. of the heavenly bodies, of the laws by which these are regulated, and of the causes on which they depend. It is unquestionably the most sublime of all the sciences. No subject has been longer or more successfully studied. Although it may be interesting to take a brief sketch of the history of this science, yet there can be no comparison drawn between the wide observations of the earlier observers, and the precision and general views of modern astronomers. To ascertain the real motions of the heavenly bodies was a difficult task, and required the united observations of many ages. To ascertain the laws and causes of these motions, demanded the exertions of powers almost beyond the reach of the human faculties. This has however been accomplished, and it has been demonstrated that the most minute movements of the heavenly bodies depend upon the same general law with the rest, and to be the consequence of it. Astronomy has therefore been highly regarded, as exhibiting one of the most remarkable instances of the extent and powers of the reasoning faculties. It has moreover conferred upon mankind the greatest benefits, in many respects, as will be shewn in the course of the present work, and may be properly considered as the teacher and guide of the art of navigation.

The early history of astronomy admits of no regular elucidation. It is probable that some knowledge of the kind must have been nearly coeval with the human race, as well from motives of curiosity, as from the connection which it has with the common concerns of life. Traces of it have accordingly been found among various nations remote from each other, which shew that the most remarkable phenomena must have been observed, and a knowledge of them disseminated at a very remote period. But in what age or country the science first originated, or by whom it was in those early times methodized and improved, is not now known. Such, however, as wish for every information that the subject admits of, we refer to the learned and very elaborate history of ancient and modern astronomy, by M. Bailly, a man of the highest reputation in the scientific world, and who was basely and cruelly murdered in the zenith of his celebrity, by the bloodthirsty Robespierre, whose savage ambition was to efface from the earth every thing great, virtuous, and excellent.

M. Bailly endeavours to trace the origin of astronomy among the Chaldeans, Egyptians, Persians, Indians, and Chinese, to a very early period. From the researches which he has made on this subject, he is led to conclude that the knowledge common to the whole of those nations has been derived from the same original source; namely, a most ancient and highly cultivated people of Asia, of whose memory every trace is now extinct; but who have been the parent instructors of all around them. The situation of this ancient people he conjectures to have been in Siberia about the 50th degree of north latitude. Among various other coincidences, he observes, that many of the European and Asiatic nations attribute their origin to that quarter, where the civil and religious rites, common to each, were probably first formed.

Without going farther back, we may observe, that the Egyptians were early cultivators of this science, and that among the Greeks, Thales, who travelled into Egypt, and who was the founder of the Ionian sect, appears to have been the first who taught his countrymen the globular figure of the earth, the obliquity of the ecliptic, and the causes of solar and lunar eclipses; which latter phænomena he is also said to have been able to predict. Thales had for his successors Anaximander, Anaximenes, and Anaxagoras, to the first of whom is attributed the invention of the gnomon, and geographical charts; but for which he was probably indebted to the Egyptians. He is also said to have maintained that the sun was a mass of fire as large as the earth, which, though far below the truth with respect to size, was an opinion, for those early times, that does its author much credit, though to him, as in the case of Galileo, the truths he had discovered were the cause of persecution. Both himself and his children were proscribed by the Athenians, for his attempting to subject the works of the gods to immutable laws; and his life would have paid the sacrifice of his temerity, but for the care of Pericles, his friend and dis-

ciple, who got his sentence of death changed into exile. Next after the Ionian school, was that of Pythagoras, who was born at Samos, about the year 586 before the Christian æra, and who, in the celebrity he acquired, far exceeded his predecessors. Like Thales, he visited Egypt, and afterwards the Brachmans of India, from whom he is supposed to have obtained many of the astronomical truths which he brought with him into Italy, to which country he was obliged to retire on account of the despotism which then prevailed at Athens. Here he first taught the true system of the world, which, many centuries after, was revived by Copernicus; but hid his doctrines from the vulgar, in imitation of the Egyptian priests, who had been his instructors. It was even thought, in this school, that the planets were inhabited bodies, like the earth; and that the stars, which are disseminated through infinite space, are suns, and the centres of other planetary systems. They also considered the comets as permanent bodies, moving round the sun; and not as perishing meteors, formed in the atmosphere, as they were thought to be in after times. From this time to the foundation of the school of Alexandria, the history of astronomy among the Greeks offers nothing remarkable, except some attempts of Eudoxus to explain the celestial phænomena; and the celebrated cycle of 19 years, which had been imagined by Meton, in order to conciliate the solar and lunar motions. This is the most accurate period, for a short interval of time, that could have been devised for embracing an exact number of revolutions of these two luminaries; and is so simple and useful, that when Meton proposed it to the Greeks, assembled at the Olympic games, as the basis of their calendar, it was received with great approbation, and unanimously adopted by all their colonies. In the school of Alexandria, we see for the first time, a combined system of observations, made with instruments proper for measuring angles, and calculated trigonometrically. Astronomy accordingly took a new form, which succeeding ages have only brought to greater perfection. The position of the stars began at this time to be determined; they traced the course of the planets with great care; and the inequalities of the solar and lunar motions became better known. It was, in short, in this celebrated school, that a new system of astronomy arose, which embraced the whole of the celestial motions; and though inferior to that of Pythagoras, and even false in theory, it afforded the means, by the numerous observations which it furnished, of detecting its own fallacy, and of enabling astronomers in later times to discover the true system of nature. It was from their observations of the principal zodiacal stars, that Hipparchus was led to discover the precession of the equinoxes; and Ptolemy also founded upon them his theory of the motions of the planets. Next after these was Aristarchus of Samos, who made the most delicate elements of the science the objects of his research. Among other things of this kind, he attempted to determine the magnitude and distance of the sun; and though, as may be supposed, the results he obtained were considerably wide of the truth, the methods he employed to resolve these difficult problems do great honour to his genius. The celebrity of his successor Eratosthenes, arises chiefly from his attempt to measure the earth, and his observations on the obliquity of the ecliptic. Having remarked at Syene, a well which was enlightened to its bottom by the sun, on the day of the summer solstice, he observed the meridian height of the sun on the same day at Alexandria; and found that the celestial arc contained between the two places was the 50th part of the whole circumference; and as their distance was estimated at 500 stadia, he fixed the length of a great circle of the earth at 250,000; but as the length of the stadium employed by this astronomer is not known, we cannot appreciate the exactness of his measurement. Among others who cultivated and improved this science, we may also mention the celebrated Archimedes, who constructed a kind of planetarium, or orrery, for representing the principal phænomena of heavenly bodies. But of all the astronomers of antiquity, Hipparchus of Bithynia is the one, who, by the number and precision of his observations, as well as by the important result which he derived from them, is the most entitled to our esteem. He flourished at Alexandria about the year 162 before the Christian æra; and began his astronomical labours by attempting to determine, with more exactness than had hitherto been done, the length of the tropical year, which he fixed at 365 days, 5 hours, and 55 minutes, being nearly $4\frac{1}{2}$ minutes too great. Like most of his predecessors, he founded his system upon an uniform circular motion of the sun; but instead of placing the earth

in the centre of the solar orbit, he removed it to the distance of $\frac{1}{24}$th part of the radius, and fixed the apogee to the sixth degree of Gemini. By means of these data, he formed the first solar tables of which any mention is made in the history of astronomy; and though defective, and even erroneous in principle, they are a durable monument of his genius, which three centuries afterwards were respected by Ptolemy, without his presuming to alter them. The great astronomer next considered the motions of the moon, and endeavoured to measure the exact time of her revolution, by a comparison of ancient eclipses. He also determined the eccentricity and inclination of her orbit, as well as the motion of her nodes and apogee; and calculated all the eclipses that were to happen for 600 years to come.

Between the time of Hipparchus and Ptolemy, the chief observers of any note are Agrippa, Menelaus, and Theon; the two latter of which are better known as geometricians than astronomers. We remark, however, in this interval, the reformation of the calendar by Julius Cæsar, and a more exact knowledge of the flux and reflux of the ocean. We pass over the dark ages, and observe that Frederic II. about 1230, set himself to restore some decayed universities, and founding a new one at Vienna. He also caused the works of Aristotle and Ptolemy's Almagest, to be translated into Latin; from which latter circumstance we may date the revival of astronomy in Europe. Two years after this, John of Halifax, commonly known by the name of Sacro Bosco, compiled from Ptolemy, Albategnius, Alfraganus, and other Arabic astronomers, his work "De Sphæra," which continued in great estimation for more than 300 years afterwards, and was honoured with commentaries by Clavius, and other learned men. Alphonsus, King of Castile, may also be reckoned as one of the most zealous encouragers and protectors of this science; though being but ill seconded by the astronomers of that time, the tables which he published were not found to answer the great expense which attended them. See ALMAGEST.

About the same period also Roger Bacon, an English monk, besides many learned works of various kinds, wrote several treatises on astronomy; after which but little progress was made in the science till the time of Purbach, Regiomontanus, and Walther, who all flourished about the end of the fifteenth century; and by their labours prepared the way for the great discoveries which followed. Regiomontanus, in particular, who was born at Koningsberg, a town of Franconia, in 1426, and whose proper name was John Muller, rendered considerable services to astronomy, not only by his observations and writings, but by his trigonometrical tables of sines and tangents, which he computed to a radius of 1,000,000 for every minute of the quadrant, and by this means greatly facilitated astronomical computations. Next after these was Nicholaus Copernicus, the celebrated restorer of the old Pythagorean system of the world, which had been now set aside ever since the time of Ptolemy. He was born at Thorn, in Polish Prussia, in 1473, and having gone through a regular course of studies at Cracow, and afterwards at Rome, he was made by the interest of his uncle, who was bishop of Wormia, a canon of Frawenberg; in which peaceful retreat, after 36 years of observations and meditations, he established his theory of the motion of the earth, with such new and demonstrative arguments in its favour, that it has gradually prevailed from that time, and is now universally received by the learned throughout Europe. This great man, however, had not the satisfaction of witnessing the success of his undertaking: being threatened by the persecution of religious bigots on the one side, and with an obstinate and violent opposition from those who called themselves philosophers on the other, it was not without the greatest solicitations that he could be prevailed upon to give up his papers to his friends, with permission to make them public; but from continued importunities of this kind, he at length complied, and his book, "De Revolutionibus Orbium Cœlestium," after being suppressed for many years, was at length published, and a copy of it brought to him a few hours before his death. From Copernicus we proceed to Tycho Brahe, the celebrated Danish astronomer, who was born in 1546, and began to manifest his taste for this science at the early age of 14. An eclipse of the sun which happened in 1560, first attracted his attention; and the justness of the calculation which announced this phænomenon inspired him with a strong desire of understanding the principles upon which it was founded. But meeting with some opposition from his tutor, and a part of his family, to these pursuits, which probably served only to in-

crease his attachment to them, he made a journey into Germany, where he formed connections, and entered into a correspondence with some of the most eminent astronomers of that country, particularly with the landgrave of Hesse, who received him in the most flattering manner, and recommended him to the notice of his sovereign. Becoming by this means better known, on his return to Denmark, Frederic II. gave him the little island of Huen, at the entrance of the Baltic, where he built an observatory, under the name of Uraniburg, and in which, during a course of 20 years, he made a prodigious number of observations. His tranquillity, however, in this happy retreat, was at length interrupted; for soon after the death of Frederic, which happened in 1596, he was deprived, through the aspersions of some envious and malevolent persons, of his pension and establishment, and was not even allowed to follow his pursuits at Copenhagen; a minister of that time, of the name of Walchendorp, having forbid him to continue his observations. Happily, however, he found a powerful protector in the Emperor Rodolphus II., who ordered him to be properly provided for at his own expense, and gave him a commodious house at Prague. After residing in this city till the year 1601, he was taken off by a sudden death, in the midst of his labours, and at an age while he was yet capable of rendering great services to astronomy. This great man, as is well known, was the inventor of a kind of semi Ptolemaic system of astronomy, that was afterwards called by his name, and which he vainly endeavoured to establish instead of the Copernican, or true system. But though he was not happy in this respect, he has been of great use to astronomy, by his numerous observations and discoveries.

Tycho Brahe, in the latter part of his life, had for his disciple and assistant, the celebrated Kepler, who was born in 1571, at Wiel, in the duchy of Wirtemberg, and was one of those rare characters that appear in the world only at particular times, to prepare the way for new and important discoveries. Like his master Tycho, he appears to have attached himself to the science at a very early age; and if it be the privilege of genius to change received ideas, and to announce truths which had never before been discovered, he may justly be considered as one of the greatest men that had yet appeared. Hipparchus, Ptolemy, Tycho Brahe, and even Copernicus himself, were indebted for a great part of their knowledge to the Egyptians, Chaldæans, and Indians, who were their masters in this science; but Kepler, by his own talents and industry, has made discoveries of which no traces are to be found in the annals of antiquity. See BRAHE.

This great man, after seventeen years of meditation and calculation, having had the idea of comparing them with the powers of the numbers by which they are expressed, he found that the squares of the times of the revolutions of the planets are to each other as the cubes of their mean distances from the sun; and that the same law applies equally to their satellites. See KEPLER.

At the same time also that Kepler, in Germany, was tracing the orbits of the planets, and settling the laws of their motions, Galileo (who was born at Pisa, in Italy, in 1564) was meditating upon the doctrine of motion in general, and investigating its principles; and from the admirable discoveries which he made in this branch of the physico-mechanical sciences, Newton and Huygens were afterwards enabled to derive the most brilliant and complete theories of all the planetary motions.

About this period also, a fortunate accident produced the most marvellous instrument that human industry and sagacity could have ever hoped to discover; and which, by giving a far greater extension and precision to astronomical observations, shewed many irregularities and new phœnomena, which had hitherto remained unknown. This invention was that of the telescope, which was no sooner known to Galileo, than he set himself about to improve it; and the discoveries he was by this means enabled to make, were as new as they were surprising.

The face of the moon appeared full of cavities and asperities, resembling vallies and mountains. The sun, which had generally been considered as a globe of pure fire, was observed to be sullied by a number of dark spots, which appeared on various parts of his surface. A great number of new stars were discovered in every part of the heavens; the planet Jupiter was found to be attended with four moons, which moved round him in the same manner that our moon moves round the earth; the phases of Venus appeared like those of the moon, as had before been concluded by Copernicus,

from his theory; and, in short, most of the observations he made furnished new proofs of the truth of the Copernican system. In publishing the discoveries which he had made with this new instrument, Galileo shewed in the most incontestible manner, the annual and diurnal motion of the earth; which doctrine, however, was thought so alarming, that it was immediately declared heretical, by a congregation of cardinals, who were assembled upon the occasion; and its venerable author, one of the most virtuous and enlightened men of his age, was obliged to abjure, upon his knees, and in the most solemn manner, a truth, which nature and his own understanding had shewn him to be incontrovertible. After this, he was condemned to perpetual imprisonment; from which, however, at the end of a year, he was enlarged, by the solicitations of the grand duke; but, that he might not withdraw himself from the power of the inquisition, he was forbid to quit the territory of Florence, where he died in 1642; carrying with him the regrets of Europe, enlightened by his labours, and their indignation against the odious tribunal which had treated him so unworthily. See GALILEO.

The discoveries of Huygens succeeded those of Kepler and Galileo; and few men have, perhaps, merited more of the sciences, by the importance and sublimity of his researches. Among other things, his happy application of the pendulum to clocks, is one of the most advantageous presents that was ever made to astronomy. He was also the first who found that the singular appearances of Saturn are produced by a ring, by which the planet is surrounded; and his assiduity in observing it led him to the discovery of one of its satellites.

About this epoch, astronomy began to be more generally cultivated and improved, in consequence of the establishment of several learned societies, which, by exciting a spirit of emulation and enterprise among their members, greatly contributed to the advancement of every branch of the mathematical and physical sciences.

The chief of these were the Royal Society of London, and that of the Academy of Sciences of Paris; both of which have rendered great services to astronomy, as well by the eminent men they have produced, as by the zeal and ardour with which the science has been constantly promoted by them. Towards the latter part of the seventeenth century, and the beginning of the eighteenth, practical astronomy seems rather to have languished; but at the same time, the theoretical part was carried to the highest degree of perfection, by the immortal Newton, in his "Principia," and by the astronomy of David Gregory. About this time also clock and watch-work was greatly improved by Mr. Graham, who likewise constructed the old eight feet mural arch at the Royal Observatory at Greenwich, and the zenith sector of 24 feet radius, with which Dr. Bradley discovered the aberration of the fixed stars. The astronomical improvements in the last century have been chiefly owing to the greater perfection of instruments, and to the establishment of regular observatories in various parts of Europe. Romer, a celebrated Danish astronomer, first made use of a meridian telescope; and by observing the eclipses of Jupiter's satellites, was led to his discovery of the motion of light, which he communicated to the Academy of Sciences at Paris, in 1675.

Mr. Flamsteed was also appointed the first astronomer royal at Greenwich, about the same time, where he observed all the celestial phœnomena for more than 44 years; and, as the fruits of his labours, published a catalogue of 3000 stars, with their places, to the year 1688, as also new solar tables, and a theory of the moon, according to Horrox. Cassini, also, the first French astronomer royal, greatly distinguished himself by his numerous observations on the sun, moon, and planets, and by the improvements he made in the elements of their motions.

In 1719, Mr. Flamsteed was succeeded by Dr. Halley, the friend of Newton, and a man of the first eminence in all the classes of literature and science; who had been sent at the early age of 21, to the island of St. Helena, to observe the southern stars, a catalogue of which he published in 1679; and a few years afterwards, he gave to the public his "Synopsis Astronomiæ Cometicæ," in which he ventured to predict the return of a comet in 1758, or 1759.

On the death of Dr. Halley, in 1742, he was succeeded by Dr. Bradley, who has rendered himself highly celebrated by two of the finest discoveries that have ever been made in astronomy, the aberration of light, and the nutation of the earth's axis. Among other things, he also formed new and accurate tables of the motions of Jupiter's satellites, as well as the most correct table of refractions yet extant. Also, with a large transit instrument, and a new mural qua-

drant of eight feet radius, constructed by Bird, in 1750, he made an immense number of observations, for settling the places of all the stars in the British catalogue, together with nearly 150 places of the moon, the greater part of which he compared with Mayer's tables.

Dr. Bradley was succeeded in 1762, in his office of astronomer royal, by Mr. Bliss, but who, being in a declining state of health, died in 1765, and was succeeded by Nevil Maskelyne, D. D., the present astronomer royal, who has rendered considerable services to this science, by his publication of the "Nautical Almanac," the "Requisite Tables," &c.; and more particularly by the great assiduity and zeal he has displayed in bringing the lunar method of determining the longitude at sea into general practice.

Such was the state of astronomy, when Dr. Herschell, by augmenting the powers of telescopes beyond the most sanguine expectations, opened a scene altogether unlooked for. By this indefatigable observer, we are made acquainted with a new primary planet belonging to our system, called the Georgium Sidus, attended by six satellites, which he discovered on the 13th of March, 1781, and which being at twice the distance of Saturn from the sun, has doubled the bounds formerly assigned to the solar system. We are also indebted to him for a variety of observations on several other interesting astronomical subjects; such as the discovery of two additional satellites to Saturn, of which the number is now seven; a new method of measuring the lunar mountains; the rotation of the planets on their axis; on the parallax of the fixed stars; catalogues of double, triple stars, &c.; of nebulæ; and of the proper motion of the sun and solar system; the accounts of which, together with many other valuable papers, he has communicated from time to time in different parts of the Philosophical Transactions. A new planet has been discovered by M. Piazzi of Palermo, between Mars and Jupiter, to which has been given the name of Ceres Ferdinandia; another by Dr. Olbers; a third and a fourth have also been discovered, which we shall briefly notice farther on.

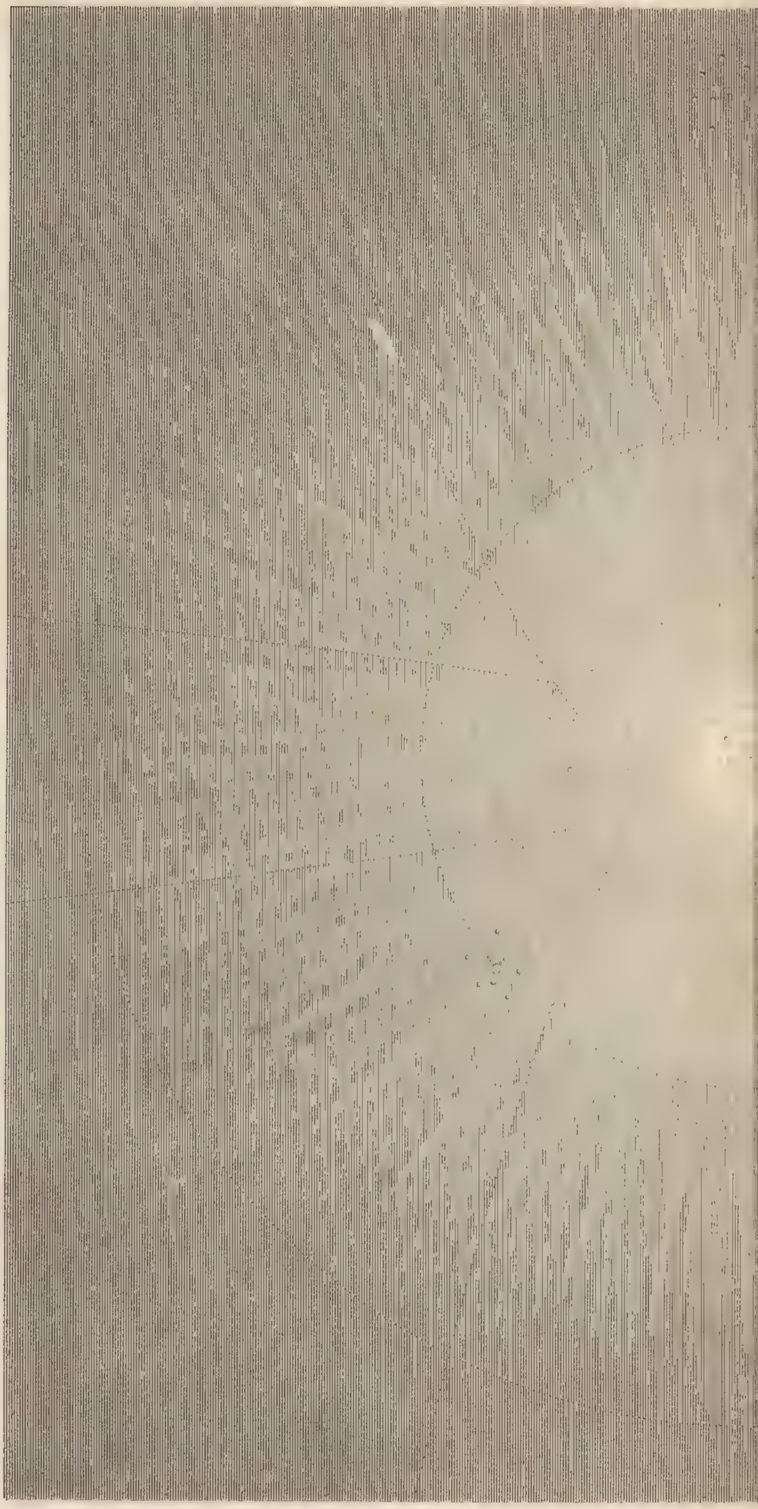
OF THE APPARENT MOTIONS OF THE HEAVENLY BODIES.

Having given a very brief sketch of the history of this science, than which, few if any, have higher claims to our veneration and regard, we proceed to consider the science itself, intending to present the reader with a popular outline of the study, freed as much as possible from mathematical principles, upon which it depends, but for which few, in comparison, can be supposed from previous studies to have any taste.

When we cast our eyes towards the heavens, we perceive a vast concave hemisphere at an unknown distance, of which the eye seems to constitute the centre. The earth stretches at our feet like an immense plain, and appears to meet and to bound the heavenly hemisphere. The circle around where the earth and heavens seem to meet and touch each other, is called the horizon. It is natural to imagine, that besides the hemispere which we perceive, there is another, exactly similar, concealed from our view by the earth, and that the earth therefore is suspended in the middle of this heavenly sphere, with all its inhabitants. A little observation turns this suspicion into certainty; for in a clear evening the heavenly hemisphere is seen studded with stars, and its appearance is changing every instant. New stars are continually rising in the east, while others are setting in the west. Those stars, that early in the evening are seen just above the eastern horizon, will at midnight be seen in the middle of the starry hemisphere, and may be traced moving gradually towards the west, till at length they sink below the horizon. If we look to the north, we perceive that many stars in that quarter never set at all, but move round and round, describing a complete circle in 24 hours: these describe their circles round a fixed point in the heavens, and the circles diminish more and more the nearer the star is to that point. This fixed point is called the north pole. There must be a similar fixed point in the southern hemisphere, called the south pole. In this way the heavenly sphere appears to turn round two fixed points, called the poles, once in every 24 hours. The imaginary line which joins the points is called the axis of the world. We shall endeavour to illustrate this by means of a figure.

Let H O (fig. 1. Plate II.) represent the circle of the horizon, seen edgeways, when it will appear as a straight line: let H P E R Q represent the complete sphere of the heavens, of which H M O is supposed to be the visible hemisphere, and H N O the invisible hemisphere: then P will be the pole or fixed point among the stars, visible to us, round which they all appear to turn,

THE SOLAR



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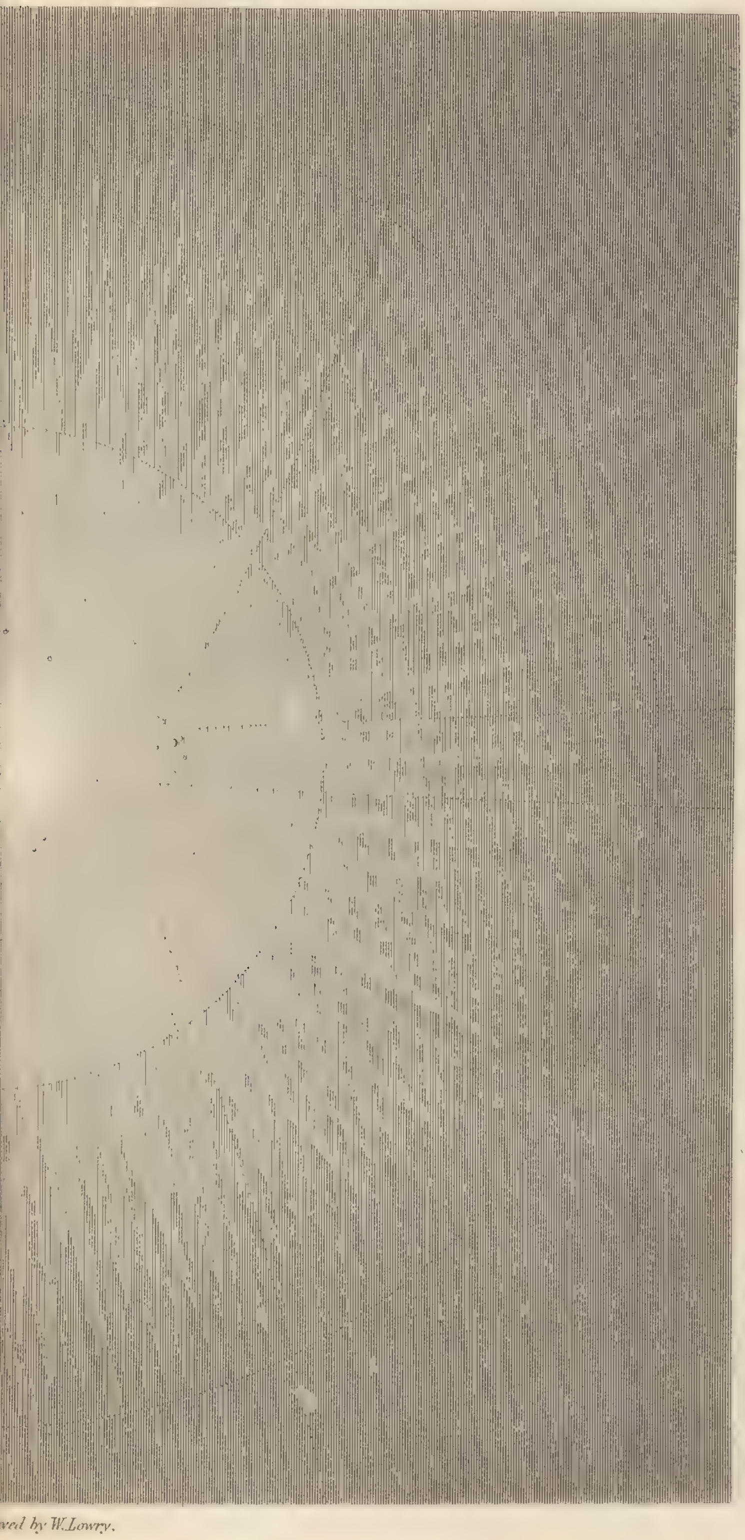

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and will be the opposite pole; the line P R will be the axis of the sphere.

To obtain precise views of the motions of the heavenly bodies, it is necessary to be able to assign precisely the place in which they are. This is done by means of several imaginary lines or circles, supposed to be described upon the surface of the sphere. These circles are divided into degrees, minutes, and seconds. The great circle of the sphere, Q E, which is perpendicular to the axis of the world, and of course 90° distant from either pole, is called the equator. The smaller circles which the stars describe in consequence of their apparent diurnal motions, are called parallels, because they are parallel to the equator. The equator divides the heavenly sphere into two equal parts, the north and south; but, to be able to assign the position of the stars, it is necessary to have another circle passing through the poles, and cutting the equator perpendicularly; this is called the meridian, which is supposed to pass through the poles, and also directly over the head of the observer M, and the point N exactly opposite to that. The first of these points is called the zenith, and the second is denominated the nadir. The meridian divides the circles described by the stars into two equal parts, and when they reach it they are either at their greatest height above the horizon, or they are at their least height. The situation of the pole is readily found, it being precisely half way between the greatest and least height of those stars that never set. Since H M O, the visible part of the heavens, contains 180°, and it is 90° between the pole P, and the equator E Q; if, therefore, we take away P E from the semicircle H M O, there remains 90° for the other two arcs P H and E O, that is, the elevation of the pole and the equator, are together equal to 90°, so that the one being known, and subtracted from 90°, the other also is found. Hence it is known, that "the elevation of the pole at any place, is the complement of the elevation of the equator:" or what that elevation wants of 90°. Hence also the "elevation of the equator is equal to the distance from the pole P to the zenith M;" for the elevation of the equator is the difference between that of the pole and 90°.

When we travel towards the north, we perceive that the north pole does not remain stationary, but rises towards the zenith, in proportion to the space that we pass over. On the contrary, it sinks just as much when we travel towards the south, from which we infer, that the surface of the earth is not plane, as would appear to a superficial observer, but curved.

The heavenly bodies appear to describe a complete circle round the earth every 24 hours; but besides these motions which are common to them all, there are several which possess motions peculiar to themselves. The sun is farther towards the south during winter than during summer; he does not therefore keep the same station in the heavens, nor describe the same circle every day. The moon not only changes her form, diminishes and increases, but, if she is observed in relation to certain fixed stars, it will be found that she proceeds to the eastward, making progress every day, till in about a month she makes a complete tour of the heavens. There are eight other stars which are continually changing their place; sometimes they seem to be moving to the westward, sometimes to the eastward, and sometimes they appear stationary for a considerable time: these are called planets. There are other bodies which appear only occasionally, move for some time with very great velocity, and afterwards advance beyond the regions visible to us: these are comets, of which one is now (November, 1807), apparent. The greater number of the heavenly bodies always retain the same, or nearly the same relative distance from each other, and are, on that account, called fixed stars.

OF THE FIGURE AND MOTION OF THE EARTH.

The earth, as we have observed, was long considered as a large circular plane, spreading out on all sides to an indefinite distance; but it is now ascertained that it is of a spherical figure, nearly resembling that of a globe. The evidence for this fact is decisive, without having recourse to scientific principles, by considering that the celebrated navigators Magellan, Sir Francis Drake, Lord Anson, and captain Cooke, have all at different times sailed round the earth. They set out from European ports, and, by steering their course westward, arrived at length at the very place from whence they departed, which could not have happened, had the earth been of any other than a spherical or a globular figure. This form is also apparent, from the circular appearance of the sea itself, and the circumstances which attend large objects when seen at a distance on its surface. For

when a ship goes out to sea, we first lose sight of the hull or body of the vessel, see fig. 4; afterwards that of the rigging; and at last can discern only the top of the mast, which is evidently owing to the convexity of the water, between the eye and the object; for otherwise the largest and most conspicuous part would be visible the longest. Another proof is taken from the shadow of the earth upon the face of the moon, during the time of a lunar eclipse; for the moon, having no light but what it receives from the sun, and the earth being interposed between them, the moon must either wholly or in part become obscure. And since in every eclipse of this kind, which is not total, the obscure part always appears to be bounded by a circular line, the earth itself, for that reason, must be spherical; it being evident that none but a spherical body can, in all situations, cast a circular shadow.

It is not ascertained who was the first person that asserted the figure of the earth to be spherical, but the opinion is of very great antiquity. For when Babylon was taken by Alexander the Great, it was known that the philosophers in that city had been long in the habit of calculating eclipses, which they could not have accomplished without a knowledge of the true figure of the earth. Thales, who flourished six centuries before the birth of Christ, predicted, according to the testimony of Herodotus, an eclipse of the sun. Hence it should seem, that in those early days, the globular figure of the earth had been by the learned investigated and credited. This being known, its magnitude would also soon be discovered: the solution of this apparently difficult problem engaged the attention of many great men about the same period; and though the measures which they have given are wide of the truth, and even very different from one another, yet this may be imputed to the inaccuracy of their instruments, and the want of mathematical knowledge rather than to the impracticability in the thing itself. Without, however, entering upon this subject, we may observe, that the universe in general, as well as the solar system in particular, are in some measure connected with the motion of the globe that we inhabit. By the universe may be understood the whole frame of nature, to the utmost extent of the creation, and by the solar system is meant, that portion of it which comprehends the sun, planets, satellites, and comets. Of this system the sun is supposed to be in the centre, round which there are eleven planets continually revolving.

If we can form a notion of the manner in which the earth moves, we shall easily conceive the motions of all the rest of the planets, and by that means obtain a complete idea of the order and œconomy of the whole system. And in order to this, nothing more is necessary than to consider the common appearances of the heavens, which are constantly presented to our view, and attend to the consequences. For since it is well known that the sun and stars appear to move daily from east to west, and to return nearly to the same places in the heavens again in twenty-four hours, it follows that they must really move, as they appear to do, or else that we ourselves must be moved, and attribute our motion to them: it being a self-evident principle, that if two things change their situation with respect to each other, one of them, at least, must have moved. But if this change be owing to the revolution of the stars, we must suppose them to be endowed with a motion so exceedingly swift, as to exceed all conception; since it is now known, by calculations founded on the surest observations, that their distances from us are so immense, and the orbits they have to run round so prodigiously great, that the nearest of them would move at least one hundred thousand miles in a minute. Now as nature never does that in a complicated and laborious manner, which may be done in a more simple and easy one, it is certainly more agreeable to reason, as well as to the power and wisdom of the Creator, that these effects should be produced by the motion of the earth; especially as such a motion will best account for all the celestial appearances, and at the same time preserve that beautiful simplicity and harmony which is found to prevail in every other part of the creation. And this argument will appear still more forcible, if we compare the vast bulk of the celestial bodies with the bulk of the earth. For it is now well known, that the sun is above a million of times larger than the earth; and from the best modern observations it appears, that many of the stars are at least equally large. It is much more probable, therefore, that the earth revolves round its axis, with an easy natural motion, once in twenty-four hours, than that those immense bodies should be carried from one place to another, with such incredible swiftness. Nor is it any objection to this

rotation of the earth that we are unable to perceive it. For as the motion of a ship at sea, when she sails swiftly over the smooth surface of the water, is almost imperceptible to the passengers and company on board; much more so must it be with such a large body as the earth, which has no impediments or obstacles of any kind to meet with in its way, or to disturb its motion. And in a manner equally easy may another objection be removed, which has frequently been brought against this doctrine. It has been asserted, that if the earth moved, a stone dropped from the top of a tower, or any other high building, would not fall just at the bottom of it, as the building must have advanced considerably forward during the time of the fall. But this is evidently a mistake; for it is well known, by repeated experiments, that if a body be projected from another body in motion, it will always partake of the motion of that other body. Thus, a stone dropped from the top of a mast, while the ship is under sail, is not left by the vessel, but falls exactly at the foot of the mast. And if a bottle of water be hung up in the cabin, with its neck downwards, it will empty itself, drop by drop, into another bottle placed exactly underneath it, though the ship shall have run many feet whilst each drop was in the air. This motion of the earth round its axis, which, from the instances already given, has been sufficiently proved, is called its diurnal or daily motion, and is that which occasions the regular return of day and night, and all the celestial appearances before mentioned. But there is also another motion of the earth, called its annual or yearly motion, which occasions the various vicissitudes of the seasons, summer, winter, spring, and autumn. And the proofs of this second motion may be easily gathered from celestial appearances, in nearly the same manner as the former. For as that luminary seems to move round the earth, from east to west, in the space of a day, which is really owing to the diurnal revolution of the earth upon its axis, in a contrary direction; so likewise he seems to have an annual motion in the heavens, and to rise and set continually in different parts of them; which is certainly occasioned by the daily motion of the earth in its orbit, or path round the sun, which it completes in the space of a year.

OF THE SOLAR SYSTEM.

It is fully proved that the planets, with the earth which we inhabit, and also the moon, revolve round the sun, which is fixed in the centre of the system. There are two kinds of planets, primary and secondary. The first move round the sun, and respect him only as the centre of their motions. The secondary planets, called also satellites or moons, are smaller planets, revolving round the primary, while they, with the primary planets about which they move, are carried round the sun. The planets move round the sun at various distances, some being much nearer to him than our earth, and others being much farther off. There are 11 primary planets, which are situated with respect to their distances from the sun as follows: Mercury ☿; Venus ♀; the Earth ⊕; Mars ♂; Ceres, Pallas, Juno, Vesta, Jupiter ♃; Saturn ♄; and the Herschel planet, or the Georgium Sidus ♅. (See Plate I. Astronomy.) Of these our earth is accompanied by one moon, Jupiter has four moons, Saturn has seven moons, and the Herschel planet has six moons. None of these moons, except our own, can be seen without a good telescope. The other five planets do not appear to have any satellites, or moons. All the planets move round the sun from west to east, and in the same direction do the moons revolve round their primaries, excepting those of the Herschel planet, which seem to move in a contrary direction. The paths in which they move round the sun are called their orbits. These orbits are elliptical; but the eccentricity of the ellipses is so small, that they approach very nearly to circles. They perform their revolutions also in very different periods of time. The time of performing their revolutions is called their year. The planets are evidently opaque bodies, and they shine only by reflecting the light which they receive from the sun; for Mercury and Venus, when viewed by a telescope, often appear to be only partly illuminated, and have the appearance of our moon when she is cusped or horned, having the illumined part always turned towards the sun. From the appearance of the boundary of light and shadow upon their surfaces, we conclude that they are spherical; which is confirmed by some of them having been found to turn periodically on their axes. Venus and Mercury being nearer to the sun than our earth, are called inferior planets, and all the rest, which are without the earth's orbit, are called superior planets. That the first go round the sun is certain, because they are seen sometimes passing between us and the sun.

and sometimes they go behind it. That their orbits are within that of the earth is evident, because they are never seen in opposition to the sun, that is, appearing to rise from the horizon in the east when the sun is setting in the west, which is another proof that the earth is not the centre of celestial motions. On the contrary, the orbits of all the other planets surround that of the earth; for they sometimes are seen in opposition to the sun, and they never appear to be horned, but always nearly or quite full, though sometimes Mars appears a little gibbous, or somewhat deficient from full.

Since all the planets move round the sun in elliptical orbits, the sun itself is situated in one of the foci of each ellipse. That focus is called the lower focus. If we suppose the plane of the earth's orbit, which passes through the centre of the sun, to be extended in every direction as far as the fixed stars, it will mark out among them a great circle, which is the ecliptic; and with this the situations of the orbits of all the other planets are compared. The planes of the orbits of all the other planets must necessarily pass through the centre of the sun; but if extended as far as the fixed stars, they form circles different from one another, as also from the ecliptic; one part of each orbit being on the north, and the other on the south side of the ecliptic. Therefore the orbit of each planet cuts the ecliptic in two opposite points, which are called the nodes of that particular planet, and the nodes of one planet cut the ecliptic in planes different from the nodes of another planet. A line passing from one node of a planet to the opposite node, or the line in which the plane of the orbit cuts the ecliptic, is called the line of nodes. That node where the planet passes from the south to the north side of the ecliptic is called the ascending node, and the other is the descending node. The angle which the plane of a planet's orbit makes with the plane of the ecliptic is called the inclination of that planet's orbit. Thus fig. 2, Plate II. where F represents the sun, the points A and B represent the nodes, and the line A B the line of nodes formed by the intersection of the planes of the orbits C and D. The angle E F G is the angle of inclination of the planes of the two orbits to each other. A line drawn from the lower focus of a planet's orbit (*viz.* where the sun is) to either end of the conjugate axis of its orbit, (which line is equal to half the transverse axis) is called the mean distance of the planet from the sun. But according to some, the mean distance is a mean proportional between the two axes of that planet's orbit. The distance of either focus from the centre of the orbit is called its eccentricity. The two points in a planet's orbit which are farthest and nearest to the body round which it moves are called the apsides; the former of which is called the higher apsis, or aphelion; the latter is called the lower apsis, or perihelion. The diameter which joins these two points is called the line of the apsides. When the sun and moon are nearest to the earth, they are said to be in perigee. When at their greatest distance from the earth they are said to be in apogee. When a planet is situated so as to be between the sun and the earth, or so that the sun is between the earth and the planet, then that planet is said to be in conjunction with the sun. When the earth is between the sun and any planet then that planet is said to be in opposition. It is evident that the two inferior planets must have two conjunctions with the sun, and the superior planets can have only one, because they can never come between the earth and the sun. When a planet comes directly between us and the sun, it appears to pass over the sun's disc, or surface, and this is called the transit of the planet. When a planet moves from west to east, *viz.* according to the order of the signs, it is said to have direct motion, or to be in consequentia. Its retrogade motion, or motion in antecedentia, is when it appears to move from east to west, *viz.* contrary to the order of the signs. The place that any planet appears to occupy in the celestial hemisphere when seen by an observer supposed to be placed in the sun, is called its heliocentric place. The place it occupies when seen from the earth is called its geocentric place.

The planets do not move with equal velocity in every part of their orbits, but they move faster when they are nearest to the sun; and slower in the remotest part of their orbits; and they all observe this remarkable law, that if a straight line be drawn from the planet to the sun, and this line be supposed to be carried along by the periodical motion of the planet, then the areas which are described by this right line and the path of the planet are proportional to the times of the planet's motion. That is, the area described in two days is double that which is described in one day, and a third part of that which is described in six days, though the arcs or portions of the

orbit described are not in that ratio. The planets being at different distances from the sun, perform their periodical revolutions in different times: but it has been found that the cubes of their mean distances are constantly as the squares of their periodical times; *viz.* of the times of their performing their periodical revolutions. These two last propositions were discovered by Kepler, by observations on the planets; but Sir Isaac Newton demonstrated, that it must have been so on the principle of gravitation, which formed the basis of his theory. This law of universal attraction, or gravitation, discovered by Newton, completely confirms the system of Copernicus, and accounts for all the phenomena which were inexplicable on any other theory. The sun, as the largest body in our system, forms the centre of attraction, round which all the planets move; but it must not be considered as the only body endued with attractive power, for all the planets also have the property of attraction, and act upon each other as well as upon the sun. The actual point therefore about which they move will be the common centre of gravity of all the bodies which are included in our system; that is, the sun, with the primary and secondary planets. But because the bulk of the sun greatly exceeds that of all the planets put together, this point is in the body of the sun. The attraction of the planets on each other also somewhat disturbs their motions, and causes some irregularities. It is this mutual attraction between them and the sun that prevents them from flying off from their orbits by the centrifugal force which is generated by their revolving in a curve, while the centrifugal force keeps them from falling into the sun by the force of gravity, as they would do if it were not for this motion impressed upon them. Thus these two powers balance each other, and preserve order and regularity in the system. It is well known, that if, when a body is projected in a straight line it be acted upon by another force, drawing it towards a centre, it will be made to describe a curve, which will be either a circle or an ellipsis, according to the proportion between the projectile and centripetal force. If a planet at B (fig. 3, Plate II.) gravitates or is attracted towards the sun, S, so as to fall from B to *y*, in the time that the projectile force would have carried it from B to X, it will describe the curve B Y by the combined action of these two forces in the same time that the projectile force singly would have carried it from B to X, or the gravitating power singly have caused it to descend from B to *y*; and these two forces being duly proportioned, the planet obeying them both will move in the circle B Y T V. But if, whilst the projectile force would carry the planet from B to *b*, the sun's attraction should bring it down from B to 1, the gravitating power would then be too strong for the projectile force, and would cause the planet to describe the curve B C. When the planet comes to C, the gravitating power (which always increases as the square of the distance from the sun, S, diminishes) will be yet stronger for the projectile force, and by conspiring in some degree therewith, will accelerate the planet's motion all the way from C to K, causing it to describe the arcs B C, C D, D E, E F, &c. all in equal times. Having its motion thus accelerated, it thereby acquires so much centrifugal force, or tendency to fly off at K, in the line K *k*, as overcomes the sun's attraction; and the centrifugal force being too great to allow the planet to be brought nearer to the sun, or even to move round him in the circle *k l m n*, &c. it goes off, and ascends in the curve K L M N, &c. its motion decreasing as gradually from K to B as it increased from B to K, because the sun's attraction now acts against the planet's projectile motion just as much as it acted with it before. When the planet has got round to B, its projectile force is as much diminished from its mean state as it was augmented at K; and so the sun's attraction being more than sufficient to keep the planet from going off at B, it describes the same orbit over again by virtue of the same forces or powers. A double projectile force will always balance a quadruple power of gravity. Let the planet at B have twice as great an impulse from thence towards X as it had before; that is, in the same length of time that it was projected from B to *b*, as in the last example; let it now be projected from B to *c*, and it will require four times as much gravity to retain it in its orbit; that is, it must fall as far as from B to 4 in the time that the projectile force would carry it from B to C, otherwise it would not describe the curve B D, as is evident from the figure. But in as much time as the planet moves from B to C, in the higher part of its orbit, it moves from I to K or from K to L in the lower part thereof; because from the joint action of these two forces, it must always describe equal areas in equal times throughout its annual course. These areas are represented by the triangles B S C, C S D, D S E, E S F,

&c. whose contents are equal to one another from the properties of the ellipsis. We have now given a general idea of the solar system; we shall next describe the bodies that compose it.

Of the sun. The sun, as the most conspicuous and most important of all the heavenly bodies, would naturally claim the first place in the attention of astronomers. Accordingly its motions were first studied, and they have had considerable influence on all the other branches of the science. That the sun has a motion of its own, independent of the apparent diurnal motion common to all the heavenly bodies, and in a direction contrary to that motion, is easily ascertained, by observing with care the changes which take place in the starry hemisphere during a complete year. If we note the time at which any particular star rises, we shall find that it rises somewhat sooner every successive day, till at last we lose it altogether in the west. But if we note it after the interval of a year, we shall find it rising precisely at the same hour as at first. Those stars which are situated nearly in the track of the sun, and which set soon after him, in a few evenings lose themselves altogether in his rays, and afterwards make their appearance in the east before sunrise. The sun then moves towards them in a direction contrary to his diurnal motion. It was by observations of this kind that the ancients ascertained his orbit. But at present this is done with greater precision, by observing every day the height of the sun when it reaches the meridian, and the interval of time which elapses between his passing the meridian and that of the stars. The first of these observations gives us the sun's daily motion northward or southward, in the direction of the meridian; and the second gives us his motion eastward in the direction of the parallels; and by combining the two together we obtain his orbit. The height of the sun from the horizon, when it passes the meridian, on the arch of the meridian between the sun and the horizon, is called the sun's altitude. The ancients ascertained the sun's altitude in the following manner:—They erected an upright pillar at the south end of a meridian line, and when the shadow of it exactly coincided with that line, they accurately measured the shadow's length, and then, knowing the height of the pillar, they found by an easy operation in plane trigonometry the altitude of the sun's upper limb, whence, after allowing for the apparent semi-diameter, the altitude of the sun's centre was known. But the methods now adopted are much more accurate. In a known latitude, a large astronomical quadrant, of six, eight, or ten feet radius, is fixed truly upon the meridian; the limb of this quadrant is divided into minutes and smaller subdivisions by means of a vernier, and it is furnished with a telescope, having cross hairs, &c. turning properly upon the centre. By this instrument the altitude of the sun's centre is very carefully measured, and the proper deductions made. The orbit in which the sun appears to move is called the ecliptic. It does not coincide with the equator, but cuts it, forming with it an angle, which in the year 1769 was determined by Dr. Maskelyne at $23^{\circ}\ 28'\ 10''$, or $23^{\circ}.46944$. This angle is called the obliquity of the ecliptic.

It is known that the apparent motion of the sun in its orbit is not uniform. Observations, made with precision, have ascertained, that the sun moves fastest in a point of his orbit situated near the winter solstice, and slowest in the opposite point of his orbit near the summer solstice. When in the first point, the sun moves in 24 hours $1^{\circ}.01943$; in the second point, he moves only $0^{\circ}.95319$. The daily motion of the sun is constantly varying in every place of its orbit between these two points. The medium of the two is $0^{\circ}.98632$, or $59'\ 11''$, which is the daily motion of the sun about the beginning of October and April. It has been ascertained, that the variation in the angular velocity of the sun is very nearly proportional to the mean angular distance of it from the point of its orbit where its velocity is greatest. It is natural to think, that the distance of the sun from the earth varies as well as its angular velocity. This is demonstrated by measuring the apparent diameter of the sun. Its diameter increases and diminishes in the same manner and at the same time with its angular velocity, but in a ratio twice as small. In the beginning of January his apparent diameter is about $32'\ 39''$, and at the beginning of July it is about $31'\ 34''$, or more exactly, according to De la Place, $32'\ 35'' = 1955''$ in the first case, and $31'\ 18'' = 1878''$ in the second. Opticians have demonstrated, that the distance of any body is always reciprocally as its apparent diameter. The sun must follow the same law; therefore its distance from the earth increases in the same proportion that its apparent diameter diminishes. In that

point of the orbit in which the sun is nearest the earth, his apparent diameter is greatest, and his motion swiftest; but when he is in the opposite point, both his diameter and the rapidity of his motion are the smallest possible.

To determine the distance of the sun from the earth, has always been an interesting problem to astronomers, and they have tried every method which astronomy or geometry possesses in order to resolve it. The amplest and most natural is that which mathematicians employ to measure distant terrestrial objects. From the two extremities of a base whose length is known, the angles which the visual rays from the object, whose distance is to be measured, make with the base, are measured by means of a quadrant; their sum subtracted from 180° gives the angle which these rays form at the object where they intersect. This angle is called the parallax, and when it is once known it is easy, by means of trigonometry, to ascertain the distance of the object. Let A B, in fig. 4, be the given base, and C the object whose distance we wish to ascertain. The angles C A B and C B A, formed by the rays C A and C B with the base, may be ascertained by observation; and their sum subtracted from 180° leaves the angle A C B, which is the parallax of the object C. It gives us the apparent size of the base A B as seen from C. When this method is applied to the sun, it is necessary to have the largest possible base. Let us suppose two observers on the same meridian, observing at the same instant the meridian altitude of the centre of the sun, and his distance from the same pole. The difference of the two distances observed will be the angle under which the line which separates the observers will be seen from the centre of the sun. The position of the observers gives this line in parts of the earth's radius. Hence, it is easy to determine, by observation, the angle at which the semidiameter of the earth would be seen from the centre of the sun. This angle is the the sun's parallax. But it is too small to be determined with precision by that method. We can only conclude from it, that the sun's distance from the earth is at least equal to 10,000 diameters of the earth. Other methods have been discovered for finding the parallax with much greater precision. It amounts very nearly to 8″.8: hence it follows that the distance of the sun from the earth amounts to at least 23.405 semidiameters of the earth.

The sun was long considered, from its constant emanation of heat and light, as an immense globe of fire. When viewed through a telescope several dark spots are visible on its surface, which are of various sizes and durations. From the motion of these spots the sun has been found to move round its axis, and its axis is found to be inclined to the ecliptic. Various opinions have been formed respecting these spots; they have been considered as opaque islands in the liquid igneous matter, and by some as pits or cavities in the body of the sun. In 1788, Mr. King published a Dissertation on the Sun, in which he advanced that the real body of the sun is less than its apparent diameter; that we never discern the real body of the sun itself, except when we behold its spots; that the sun is inhabited as well as our earth, and is not necessarily subject to burning heat, and that there is in reality no violent elementary heat existing in the rays of the sun themselves essentially, but that they produce heat only when they come into contact with the planetary bodies. Several years after this Mr. Herschel published his theory of the nature of the sun, which is briefly as follows: he considers the sun as a most magnificient habitable globe, surrounded by a double set of clouds. Those which are nearest its opaque body are less bright, and more closely connected together than those of the upper stratum, which form the luminous apparent globe we behold. This luminous external matter is of a phosphoric nature, having several accidental openings in it, through which we see the sun's body, or the more opaque clouds beneath. These openings form the spots that we see.

Mercury. This planet being the nearest to the sun, and the least in magnitude, is very seldom visible. It never appears more than a few degrees from the sun's disc, and is generally lost in the splendor of the solar beams. On this account astronomers have had few opportunities of making accurate observations upon it; no spots have been observed upon it, consequently the time of its rotation on its axis is not known. Being an inferior planet it consequently must shew phases like the moon; and it never appears quite full to us. It is seen sometimes passing over the sun's disc, which is called its transit.

Venus is the brightest and largest to appearance of all the planets, and is distinguished from the rest by her superiority of lustre. It is generally called the Morning or Evening Star, according as it precedes or

follows the apparent course of the sun. Some have thought that they could discover spots upon its disc; but Herschel has not been able to see them; consequently the time of rotation round its axis is not decidedly known. Venus also appears with phases, and transits sometimes take place; which are of very great importance in astronomy.

The *Earth* which we inhabit is as has been proved, a globular body; it is not, however, a perfect sphere, but a spheroid, having its equatorial diameter longer than the polar diameter or axis. It is consequently flattest at the poles, and more protuberant at the equator. The diameter at the equator is 7893 English miles; that at the pole is 7928 miles. The surface of the earth is much diversified with mountains and vallies, land and water. The highest mountains in it are the Andes in South America, some of which are about four miles in perpendicular altitude. About two-thirds of the globe is covered with water. In consequence of the earth's being a globe, people standing upon opposite sides of it must have their feet towards to each other. When in this situation they are called antipodes to each other. Hence it appears that there is no real up or down; for what is up to one country is down to another. It must seem strange to those who are ignorant of the shape of the the earth, to suppose that if we could bore a hole downwards, deep enough, we should come to the other side of the world, where we should find a surface and sky like our own; yet if we reflect a moment we shall perceive that this is perfectly true. As we are preserved in our situations by the power of attraction which draws us towards the centre of the earth, we call that direction down which tends to the centre, and the contrary. We mentioned before that the earth has two motions, the one a diurnal motion round its own axis, the other an annual motion round the sun. It is the former which causes light and darkness, day and night; for when one side of the earth is turned towards the sun it receives his rays and is illuminated, causing day; on the contrary, when one side of the earth is turned from the sun, we are in darkness, and then we have night. We see, therefore, by how much more simple means this change is effected, than they imagined who supposed that the earth was fixed, and that the immense globe of the sun was whirled round the earth with the amazing velocity that would be necessary. Twilight is owing to the refraction of the rays of light by our atmosphere through which they pass, and which, by bending them, occasion some to arrive at a part of the earth that could not receive any direct rays from the sun. It is the annual motion of the earth round the sun which occasions the diversity of seasons. To understand this, we must observe what has been already mentioned, that the axis of the earth is inclined to the plane of its orbit $23\frac{1}{2}^{\circ}$, and it keeps always parallel to itself; that is, it is always directed to the same star. Let fig. 5, Plate II. represent the earth in different parts of its elliptic orbit. In the spring the circle which separates the light from the dark side of the globe called the terminator, passes through the poles n, s, as appears in the position A. The earth then, in its diurnal rotation about its axis, has every part of its surface as long in light as in shade; therefore the days are equal to the nights all over the world; the sun being at that time vertical to the equatorial parts of the earth. As the earth proceeds in its orbit and comes into the position B, the sun becomes vertical to those parts of the earth under the tropic, and the inhabitants of the northern hemisphere will enjoy summer on account of the solar rays falling more perpendicularly upon them; they will also have their days longer than their nights, in proportion as they are more distant from the equator; and those within the polar circle, as will be perceived by the figure, will have constant day-light. At the same time the inhabitants of the southern hemisphere have winter, their days being shorter than their nights, in proportion as they are farther from the equator; and the inhabitants of the polar regions will have constant night. The earth then continues its course to the position C, when the terminator again passes through the poles, and the days and nights are equal. After this the earth advances to the position D, at which time the inhabitants of the northern hemisphere have winter, and their days are shorter than their nights. The positions B and D are the solstitial points, and A and C the equinoctial points; they are not equidistant from each other, because the sun is not in the centre but in the focus of the ellipsis. In summer, when the earth is at B, the sun is farther from it than in the winter when the earth is at D; and in fact, the diameter of the sun appears longer in winter than in summer. The difference of heat is not owing to the sun's being nearer

to us, or more remote, but to the degree of obliquity with which its rays strike any part of the earth.

The *Moon* is, next to the sun, the most remarkable of the celestial objects. Its form is spherical like that of the earth round which it revolves, and by which it is carried round the sun. Its orbit is also elliptical, having the earth in one of the foci of the ellipsis. The moon always keeps the same side towards the earth, shewing only at one time a little more of one side, and at another time a little more of the other side. When the moon is viewed through a good telescope, its surface appears covered with ridges, mountains, pits, and cavities of great variety. Some parts of its surface also reflect less light than the rest. It has been conjectured that the part which reflects the least light is water, and the brightest part land. The heights of the lunar mountains were formerly supposed to be much greater than those of our earth; but Dr. Herschel has demonstrated that very few are more than half a mile high, and the highest little more than a mile. Several volcanos, or burning mountains, have been discovered in it. It has been doubted whether the moon has an atmosphere like ours, but the latest observations appear to prove that it has. The moon is seen by means of the light which comes to it from the sun being reflected from it. Its changes or phases depend upon its situation relatively to the earth and the sun. When the moon is in opposition to the sun, the enlightened side is turned towards the earth, and it appears full; when the moon is in conjunction with the sun, its dark side is turned towards us, and it is invisible. As it proceeds in its orbit, a small part of the enlightened side is seen, and then we have a new moon; and we continue to see more and more of the enlightened side, as the moon approaches to the state of opposition, or full moon. The waning or decreasing of the moon takes place in the same manner, but in a contrary order. The earth must perform the same office to the moon that the moon does to us; and it will appear to the inhabitants of the moon (if there be any), like a very magnificent moon, being to them about 13 times as big as the moon to us, and it will also have the same changes or phases. The moon's motion is subject to many irregularities, on account of the inclination of its orbit to the plane of the ecliptic, and the attraction of the sun and the other planets.

The moon has scarcely any difference of seasons; her axis being almost perpendicular to the ecliptic. What is very singular, one half of her has no darkness at all; the earth constantly affording it a strong light in the sun's absence; while the other half has a fortnight's darkness and a fortnight's light by turns. Our earth, as we have already observed, is undoubtedly a moon to the moon; waxing and waning regularly, but affording her 13 times as much light as she does us. When she changes to us, the earth appears full to her; and when she is in her first quarter to us, the earth is in its third quarter to her; and *vice versa.* But from one half of the moon the earth is never seen at all: from the middle of the other half, it is always seen over head; turning round almost 30 times as quick as the moon does. From the circle which limits our view of the moon, only one half of the earth's side next her is seen; the other half being hid below the horizon of all places on that circle. To her, the earth seems to be the biggest body in the universe. As the earth turns round its axis, the several continents, seas, and islands, appear to the moon's inhabitants like so many spots of different forms and brightness, moving over its surface; but much fainter at sometimes than others, as our clouds cover them or leave them. By these spots the Lunarians can determine the time of the earth's diurnal motion, just as we do the motion of the sun: and perhaps they measure their time by the motion of the earth's spots; for they cannot have a truer dial. The moon's axis is so nearly perpendicular to the ecliptic, that the sun never removes sensibly from her equator; and the obliquity of her orbit, which is next to nothing as seen from the sun, cannot cause the sun to decline sensibly from her equator. Yet her inhabitants are not destitute of means for ascertaining the length of their year, though their method and ours must differ. For we can know the length of our year by the return of our equinoxes; but the Lunarians, having always equal day and night, must have recourse to another method; and we may suppose, they measure their year by observing when either of the poles of our earth begins to be enlightened, and the other to disappear, which is always at our equinoxes, they being conveniently situated for observing great tracts of land about our earth's poles, which are entirely unknown to us. Hence we may conclude, that the year is of the same ab-

solute length both to the earth and moon, though very different as to the number of days; we having $365\frac{1}{4}$ natural days, and the Lunarians only $12\frac{1}{19}$, every day and night in the moon being as long as $29\frac{1}{2}$ on the earth.

Mars is not so bright as Venus, nor even as Jupiter, though nearer to the sun. Its colour is a little reddish. Some spots have been observed upon its surface, from which its rotation round its axis, and the inclination of its axis to the plane of its orbit, have been determined. This planet sometimes appears gibbous, but never horned, like the moon, which shews that his orbit includes that of the earth, and that he shines by a borrowed light.

Ceres Ferdinandea is a very small planet, situated next without Mars: it was discovered on the first day of the present century by Mr. Piazzi, an Italian astronomer.

Pallas is another very small planet, discovered by Dr. Olbers of Bremen, on the 28th of March, 1802. Two others have also been discovered, one by M. Harding, and the other by a pupil of Dr. Olbers. To these have been given the names of *Juno* and *Vesta*. These planets Dr. Herschel proposes to call asteroids, because they are so much smaller than any of the other planets.

Jupiter is the brightest planet next to Venus. When viewed by a telescope, several belts are observed across its disc, parallel to its equator: these belts are variable, and are supposed to be ranges of clouds in the atmosphere of the planet. Jupiter is surrounded by four moons of different sizes, which move about it in different times. These moons are sometimes eclipsed by the shadow of Jupiter falling upon them; and the eclipses have been found of great use in determining the longitudes of different places on the earth: *Ex.* Suppose two observers of an eclipse, one at London, the other at the Cape of Good Hope, the eclipse will appear at the same instant of time to both; but being situated under different meridians, they count different hours, according to which the difference of their longitude is found. Thus, if an emersion of a satellite is observed at London $9^h\ 33'\ 12''$, and at another place $10^h\ 46'\ 45''$, the difference of time is $1^h\ 13'\ 33''$, of course that other place is $18^\circ\ 23'\ 15''$ east of London.

The eclipses of Jupiter's satellites have been applied also to measure the velocity of light: by comparing the times of the apparent entrance and emersion of the satellites with tables calculated for the mean distances of the earth from the satellite, the visible emersion at the least distance is found to happen about eight minutes sooner; and at the greatest distance about eight minutes later than the tables: consequently a ray of light is about 16 minutes in passing through the earth's orbit, or eight minutes in coming from the sun to the earth. If therefore the distance be 95,000,000 of miles, the velocity of light per second is equal to $\frac{95,000,000}{8\times 60}=198$ thousand miles in a second nearly.

Saturn can hardly be seen by the naked eye. When examined by a telescope, it exhibits a very remarkable appearance. It is surrounded by a thin, flat, broad luminous ring, which surrounds the body of the planet, but does not touch it. This ring casts a strong shadow upon the planet, and is divided into two, by a distinct line in the middle of its breadth. The rings are circular, but appear elliptical from being viewed obliquely.

According to Dr. Herschel, the dimensions of the rings, and the space between, are as follows:

	Miles.
Inner diameter of the smaller ring	146,345
Outside diameter of ditto........	184,393
Inner diameter of the larger ring..	190,248
Outside diameter of ditto........	204,883
Breadth of the inner ring........	20,000
Ditto........ outer ring........	7,200
Ditto........ of vacant space...	2,839

Besides this ring, Saturn has seven moons of different sizes, and its body is surrounded also by belts, like those of Jupiter.

The *Herschel planet*, with its six satellites, have been entirely discovered by Dr. Herschel. It cannot be seen without a telescope, but it does not require a powerful one. The satellites cannot be seen without the most powerful telescopes. We shall subjoin in the opposite page a table which will contain a number of particulars relating to the planets, that will be found of great utility to the reader.

DR. MASKELYNE'S VIEW OF THE PLANETARY SYSTEM FOR 1801, DEC. 1.

	Apparent mean diameters, as seen from the earth.	Mean diameters as seen from the sun.	Mean diameters in English miles.	Mean distances from the sun in round numbers of miles.	More accurate proportional numbers of the preceding mean distances.	Densities to that of water, which is 1.	Proportions of the quantities of matter.	Inclinations of orbits to the ecliptic in 1780.	Inclinations of axis to orbits.	Rotations diurnal or round their own axis.	Eccentricities; the mean distances being 100000
The Sun...	32′ 1″.5		883246			$1\frac{2}{15}$	333928		82° 44′ 0′	25ᵈ 14ʰ 8ᵐ 0ˢ	
Mercury...	10	16″	3224	37000000	38710	$9\frac{1}{6}$	0.1654	7° 0′ 0″			7955.4
Venus	58	30	7687	68000000	72333	$5\frac{11}{15}$	0.8899	3 23 35		0 23 21	498
The Earth		17.2	7911.73	95000000	100000	$4\frac{1}{2}$	1	0 0 0	66 32	1	1681.395
The Moon	31 8	4.6	2180	95000000	100000	$5\frac{1}{2}$	0.025	5 9 3 at a mean.	88 17	29 17 44 3	
Mars	27	10	4189	144000000	152369	$3\frac{2}{7}$	0.0875	1 51 0	59 22	0 24 39 22	14183.7
Ceres	1		160	260000000	273550			10 37 56,6 in 1801.			8140.64
Pallas *	0.5.		80	266000000	279100			34 50 40 in 1801.			24630
Jupiter	39	37	89170	490000000	520279	$1\frac{1}{24}$	312.1	1 18 56 in 1780.	90 nearly.	0 9 55 37	25013.3
Saturn	18	16	79042	900000000	954072	$0\frac{13}{32}$	97.76	2 29 50 in 1780.	60 probably.	0 10 16 2	53640.42
Herschel ...	3 54	4	35112	1800000000	1908352	$0\frac{22}{100}$	16.84	0 46 20 in 1780.			90804

* Of the small planetary bodies, Juno and Vesta, enough is not yet known to reduce the facts to a tabular form.

OF COMETS.

Besides these planets already mentioned, there are some other bodies which revolve round the sun, called comets. They move in very eccentric ellipses, and their periods of revolution are so long, and so uncertainly known, that few are ever observed twice. They are only seen by us when they are in that part of their orbit which is nearest to the sun, and then they move so fast, that they soon become again invisible to us. The number of comets is unknown; numbers of small ones have been discovered by telescopes. Their distances are inconceivably great, and most of them move entirely beyond the planetary orbits; though some have descended below Mars. Their appearances are very different. Some appear only a faint vapour; others have a nucleus or solid part in the middle. When they approach the sun, they put forth the appearance of a beard or tail of luminous matter, which is sometimes of astonishing length. These tails are always directed from the sun. There are three comets, *viz.* of 1680, 1744, and 1759, that deserve to have a farther account given of them. The comet of 1680 was remarkable for its near approach to the sun; so near, that in its perihelion it was not above a sixth part of the diameter of the luminary from the surface thereof. The tail, like that of other comets, increased in length and brightness as it came nearer to the sun; and grew shorter and fainter as it went farther from him and from the earth, till that and the comet were too far off to be any longer visible. The comet of 1744 was first seen at Lausanne in Switzerland, December 13, 1743, N. S. From that time it increased in brightness and magnitude as it was coming nearer to the sun. Its diameter, when at the distance of the sun from us, measured about one minute, which brings it out equal to three times the diameter of the earth. It came so near Mercury, that if its attraction had been proportionable to its magnitude, it was thought probable it would have disturbed the motion of that planet. Mr. Betts of Oxford, however, from some observations made there, and at Lord Macclesfield's observatory at Sherburn, found, that when the comet was at its least distance from Mercury, and almost twice as near the sun as that planet was, it was still distant from him a fifth part of the distance of the sun from the earth, and could therefore have no effect upon the planet's motions. He judged the comet to be at least equal in magnitude to the earth. He says, that in the evening of January 23, this comet appeared exceedingly distinct and bright, and the diameter of its nucleus nearly equal to that of Jupiter. Its tail extended above 16 degrees from its body; and was in length, supposing the sun's parallax 10″, no less than 33 millions of miles. Dr. Bevis, in the month of May, 1744, made four observations of Mercury, and found the places of that planet, calculated from correct tables, differed so little from the places observed, as to shew that the comet had no influence upon Mercury's motion. The nucleus, which had before been always round, on the 10th of February appeared oblong, in the direction of the tail, and seemed divided into two parts, by a black stroke in the middle. One of the parts had a sort of beard brighter than the tail; this beard was surrounded by two unequal dark strokes, that separated the beard from the hair of the comet. The odd phenomena disappeared the next day, and nothing was seen but irregular obscure spaces like smoke in the middle of the tail; and the head resumed its natural form. February 15, the tail was divided into two branches; the eastern part about seven or eight degrees long, the western 24. On the 23d, the tail began to be bent; it showed no tail till it was as near to the sun as the orbit of Mars; the tail grew longer as it approached nearer the sun; and at its greatest length was computed to equal a third part of the distance of the earth from the sun. The comet of 1759 did not make any considerable appearance by reason of the unfavourable situation of the earth all the time its tail might otherwise have been conspicuous; the comet being then too near the sun to be seen by us; but deserves our particular consideration, as it was the first that ever had its return foretold. With respect to the real nature and use of the comets in the system, we are entirely unacquainted.

OF THE FIXED STARS.

The fixed stars are so called, because they are observed not to change their places in the heavens as the planets do. They appear of an infinite variety of sizes, yet for convenience, it is usual to class them into six or seven magnitudes: thus, they are called stars of the first, second, &c. magnitude. To the naked eye they appear innumerable, but this is only the consequence of their being scattered in so confused a manner, and our not being able to

see them all at one view. The whole number of stars visible to the naked eye is about 3186. But seldom above one-third of that number can be seen at one time. From the earliest ages they have been divided into groups, or constellations, which have been called by the names of various animals and objects, from a supposed resemblance to them; such as the Great Bear, the Little Bear, the Swan, &c. The fixed stars are placed at a distance from us so great, that it cannot be ascertained by any means yet known: hence, they must shine by their own light, and not by the light which they receive from our sun, as the planets do. Though it has been formerly mentioned that the relative situations of the fixed stars do not vary, yet in the course of several ages, some variations have been observed among them. Some of the larger stars have not the same precise situations that ancient observations attribute to them, and new stars have appeared, while some others which have been described, are now no longer to be found. Some stars are likewise found to have a periodical increase and decrease. Many of the fixed stars, upon examination with the telescope, are found to consist of two. Besides the phenomena already mentioned, there are many nebulæ, or parts of the heavens, which are brighter than the rest. The most remarkable of these is a broad irregular zone or belt, called the Milky-way. There are others much smaller, and some so small, that they can be seen only by telescopes. If the telescope be directed to these nebulæ, they are resolvable into clusters of stars, which appear as white clouds in instruments of less force. Dr. Herschell has rendered it highly probable, both from observation and well-grounded conjecture, that the starry heavens is replete with these nebulæ or systems of stars, and that the Milky-way is that particular nebula in which our sun is placed. Reasoning analogically from the circumstances with which we are acquainted, we may deduce, that the universe consists of nebulæ or distinct systems of stars: that each nebula is composed of a prodigious number of suns or bodies that shine by their own native splendour; and that each individual sun is destined to give light to numbers of worlds that revolve about it. What an august, what an amazing conception does this give of the works of the Creator! Instead of one world and one sun, we find thousands and thousands of suns, ranged around us at immense distances, all attended by innumerable worlds, all in rapid motion, yet calm, regular, and harmonious, invariably keeping the paths prescribed them; and these worlds peopled with myriads of intelligent beings, formed for endless progression in perfection and felicity. We shall now, in the form of a table, give the names of the constellations, and the number of stars observed in each by different astronomers.

THE ANCIENT CONSTELLATIONS.

		Ptolemy.	Tycho.	Hevelius.	Flamsteed.
Ursa Minor	The Little Bear	8	7	12	24
Ursa Major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, *Arctophilax*		23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, *Engonasin*	Hercules kneeling	29	28	45	113
Lyra	The Harp	10	11	17	21
Cygnus, *Gallina*	The Swan	10	18	47	81
Cassiopeia	The Lady in her chair	13	26	37	55
Perseus	Perseus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, *Ophiuchus*	Serpentarius	29	15	40	74
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, *Vultur*	The Eagle	15	12	23	71
Antinous	Antinous		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, *Equi sectio*	The Horse's Head	4	4	6	10
Pegasus, *Equus*	The Flying Horse	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16
Aries	The Ram	18	21	27	66

		Ptolemy.	Tycho.	Hevelius.	Flamsteed.
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion	35	30	49	95
Coma Berenices	Berenice's Hair		14	21	43
Virgo	The Virgin	32	33	50	110
Libra *Chelæ*	The Scales	17	10	20	51
Scorpio	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Pisces	The Fishes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, *Fluvius*	Eridanus, *the River*	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis Major	The Great Dog	29	13	21	31
Canis Minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	5	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4		9
Centaurus	The Centaur	37			35
Lupus	The Wolf	19			24
Ara	The Altar	7			9
Corona Australis	The Southern Crown	13			12
Piscis Australis	The Southern Fish	18			24

THE NEW SOUTHERN CONSTELLATIONS.

Columba Noachi	Noah's Dove	10
Robur Carolinum	The Royal Oak	12
Grus	The Crane	13
Phœnix	The Phenix	13
Indus	The Indian	12
Pavo	The Peacock	14
Apus, *Avis Indica*	The Bird of Paradise	11
Apis, *Musca*	The Bee or Fly	4
Chamæleon	The Chameleon	10
Triangulum Australe	The South Triangle	5
Piscis volans, *Passer*	The Flying Fish	8
Dorado, *Xiphias*	The Sword Fish	6
Toucan	The American Goose	9
Hydrus	The Water Snake	10

HEVELIUS'S CONSTELLATIONS MADE OUT OF THE UNFORMED STARS.

		Hevelius.	Flamsteed.
Lynx	The Lynx	19	44
Leo Minor	The Little Lion	—	53
Asterion et Chara	The Greyhounds	23	25
Cerberus	Cerberus	4	
Vulpecula et Anser	The Fox and Goose	27	35
Scutum Sobieski	Sobieski's Shield	7	
Lacerta	The Lizard	10	16
Camelopardalus	The Camelopard	32	58
Monoceros	The Unicorn	19	31
Sextans	The Sextant	11	41

Several stars observed by the ancients are now no more to be seen, but are destroyed; and new ones have appeared which were unknown to the ancients. Some of them have also disappeared for some time, and again become visible. We are also assured from the observations of astronomers, that some stars have been observed which never were seen before, and for a certain time they have distinguished themselves by their superlative lustre; but afterwards decreasing, they vanished by degrees, and were no more to be observed. One of these stars being first seen and observed by Hipparchus, the chief of the ancient astronomers, set him upon composing a catalogue of the fixed stars, that by it posterity might learn whether any of the stars perish, and others are produced afresh. After several ages, another new star appeared to Tycho Brahe and the astronomers who were contemporary with him; which put him on the same design with Hipparchus, namely, the making a catalogue of the fixed stars.

Of this, and other stars, which have appeared since that time, we have the following history by Dr. Halley. "The first new star in the Chair of Cassiopeia was not seen by Cornelius Gemma on the 8th of November, 1572, who says, he, that night, considered that part of the heaven in a very serene sky, and saw it not; but that the next night, November 9, it appeared, with a splendor surpassing all the fixed stars, and scarce less bright than Venus. This was not seen by Tycho Brahe before the 11th of the same month; but from thence he assures us that it gradually decreased and died away; so as in March, 1574, after 16 months, to be no longer visible; and at this day no signs of it remain. Its place in the sphere of fixed stars, by the accurate observations of the same Tycho, was $0^s\ 9^{\circ}\ 17'$ a 1^{ma} ✳ ♈, with $53^{\circ}\ 45'$ north latitude. Such another star was seen and observed by the scholars of Kepler, to begin to appear on September 30, St. Vet. anno 1604, which was not to be seen the day before; but it broke out at once with a lustre surpassing that of Jupiter; and, like the former, it died away gradually, and in much about the same time disappeared totally, there remaining no footsteps thereof in January, 1605-6. This was near the ecliptic, following the right leg of Serpentarius; and by the observations of Kepler and others, was in $7^s\ 28^{\circ}\ 00'$ a 1^{ma} ✳ ♈, with north latitude $1^{\circ}\ 56'$. These two seem to be of a distinct species from the rest, and nothing like them has appeared since. But between them, *viz.* in the year 1596, we have the first account of the wonderful star in Collo Ceti, seen by David Fabricius on the 14th of August, as bright as a star of the third magnitude, which has been since found to appear and disappear periodically; its period being precisely enough seven revolutions in six years, though it returns not always with the same lustre. Nor is it ever totally extinguished, but may at all times be seen with a six feet tube. This was singular in its kind, till that in Collo Cygni was discovered. It precedes the first star of Aries $1^{\circ}\ 40'$, with $15^{\circ}\ 57'$ south latitude. Another new star was first discovered by William Jansonius in the year 1600, in Pectore, or rather in Eductione Colli Cygni, which exceeded not the third magnitude. This having continued some years, became at length so small, as to be thought by some to have disappeared entirely; but in the years 1657, 1658, and 1659, it again arose to the third magnitude; though soon after it decayed by degrees to the fifth or sixth magnitude, and at this day is to be seen as such in $9^s\ 18^{\circ}\ 38'$ a 1^{mo} ✳ ♈, with $55^{\circ}\ 29'$ north latitude. A fifth new star was first seen by Hevelius in the year 1670, on July 15, St. Vet. as a star of the third magnitude; but by the beginning of October was scarce to be perceived by the naked eye. In April following it was again as bright as before, or rather greater than of the third magnitude, yet wholly disappeared about the middle of August. The next year, in March, 1672, it was seen again, but not exceeding the sixth magnitude: since when, it has been no further visible, though we have frequently sought for its return; its place is $9^s\ 3^{\circ}\ 17'$ a 1^{ma} ✳ ♈, and has lat. north $47^{\circ}\ 28'$. The sixth and last is that discovered by Mr. G. Kirch in the year 1686, and its period determined to be of $404\frac{1}{2}$ days; and though it rarely exceeds the fifth magnitude, yet it is very regular in its returns, as we found in the year 1714. Since then we have watched, as the absence of the moon and clearness of the weather would permit, to watch the first beginning of its appearance in a six feet tube, that, bearing a very great aperture, discovers most minute stars. And on June 15 last, it was first perceived like one of the very least telescopical stars; but in the rest of that month and July, it gradually increased, so as to become in August visible to the naked eye: and so continued till the month of September. After that, it again died away by degrees: and on the 8th of December, at night, was scarcely discernible by the tube; and as near as could be guessed, equal to what it was at its first appearance on June 25, so that this year it has been seen in all near six months, which is but little less than half its period; and the middle, and consequently the greatest brightness, falls about the 10th of September."

The late improvements in astronomy, and particularly those in the construction of telescopes, have now given astronomers an opportunity of observing the changes which take place among the stars with much greater accuracy than could be formerly done. In a paper in the 76th volume of the Philosophical Transactions, Mr. Edward Pigot gives a dissertation on the stars suspected by the astronomers of the last century to be changeable. For the greater accuracy in the investigation of his subject, he divides them into two classes; one containing those which are undoubtedly changeable, and the other those which are only suspected

to be so. The former contains a list of 12 stars, from the first to the fourth magnitudes, including the new one which appeared in Cassiopeia in 1572, and that in Serpentarius in 1604: the other contains the names of 38 stars of all magnitudes, from the first to the seventh. He is of opinion, that the celebrated new star in Cassiopeia is a periodical one, and that it returns once in 150 years. Keill is of the same opinion: and Mr. Pigot thinks, that its not being observed at the expiration of each period is no argument against the truth of that opinion; "since (says he) perhaps as with most of the variables, it may at different periods have different degrees of lustre, so as sometimes only to increase to the ninth magnitude; and if this should be the case, its period is probably much shorter." For this reason, in September, 1782, he took a plan of the small stars near the place where it formerly appeared, but in four years had observed no alteration. The star in the neck of the Whale had also been examined by Mr. Pigot from the end of 1782 to 1786, but he never found it exceed the sixth magnitude; though Mr. Goodricke had observed it on the 9th of August to be of the second magnitude, and on the 3d of September the same year it was of the third magnitude. Mr. Pigot deduced its period from its apparent equality with a smaller star in the neighbourhood, and thence found it to be 320, 328, and 337 days. The most remarkable of these changeable stars is that called Algol, in the head of Medusa. It had long been known to be variable; but its period was first ascertained by Mr. Goodricke of York, who began to observe it in the beginning of 1783. It changes continually from the first to the fourth magnitude; and the time taken up from its greatest diminution to its least is found, at a mean, to be $2^d\ 20^h\ 49^m$ and 3^s. During four hours it gradually diminishes in lustre, which it recovers during the succeeding four hours; and in the remaining part of the period it invariably preserves its greatest lustre, and after the expiration of the term its diminution again commences. According to Mr. Pigot, the degree of brightness of this star when at its minimum is variable in different periods, and he is of the same opinion with regard to its brightness when at its full; but whether these differences return regularly or not, has not been determined.

OF ECLIPSES.

When any one of the heavenly bodies is obscured or darkened by the shadow of another falling upon it, or by the interposition of any body, it is said to be eclipsed. The eclipses of the sun and moon are the most striking of any. They were formerly considered as ominous, and have often excited the dread and apprehension of the vulgar; but the improvement of science has shewn that they have no connection with future events; that they depend upon regular and invariable causes, and may be calculated and foretold with the greatest certainty. As the earth is an opaque body, enlightened only by the sun, it will cast a shadow towards that side which is farthest from the sun. If the sun and earth were of the same size, this shadow would be cylindrical, and would extend to an infinite distance; but as the sun is much larger than the earth, the shadow of the latter must be conical, or end in a point (see fig. 6.) On the sides of this conical shadow, there is a diverging shadow, the density of which decreases in proportion as it recedes from the sides of the former conical shadow: this is called the penumbra. As the moon revolves round the earth sufficiently near to pass through the shadow of the earth, an eclipse must always take place when these three are all in one straight line. An eclipse of the moon can never happen but at the time of full moon; but on account of the inclination of the moon's orbit to that of the earth, an eclipse cannot take place every full moon. When the moon passes entirely through the earth's shadow, the eclipse is total; but when only a part of it passes through the shadow, the eclipse is partial. The quantity of the moon's disc which is eclipsed, (and the same thing is to be understood of that of the sun in a solar eclipse) is expressed by twelfth parts, called digits, that is, the disc is supposed to be divided by 12 parallel lines; then if half the disc is eclipsed, the quantity of the eclipse is said to be six digits. When the diameter of the shadow through which the moon must pass is greater than the diameter of the moon, the quantity of the eclipse is said to be more than 12 digits; thus, if the diameter of the moon is to that of the shadow as four to five, then the eclipse is said to be 15 digits. The duration of a lunar eclipse is various, it sometimes lasts two or three hours. The eclipses of the sun are owing to a different cause than those of the moon. They are occasioned by the moon's coming directly between us and the sun, and therefore obstructing our view of it. When the moon

Fig. 1.

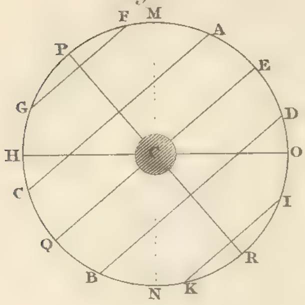


Fig. 2.

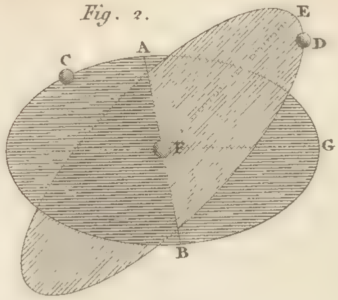


Fig. 3.

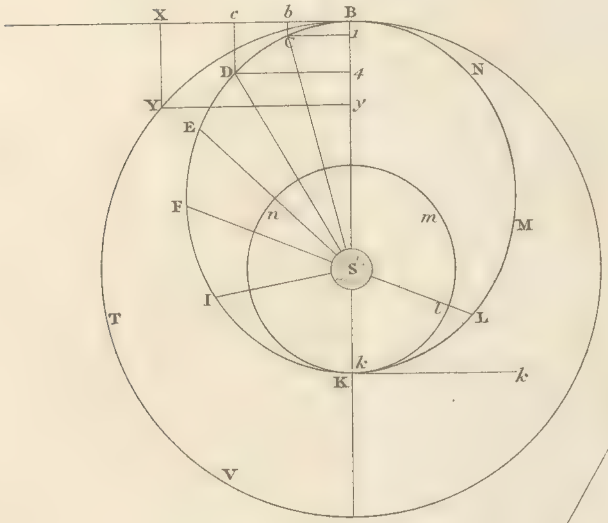


Fig. 4.

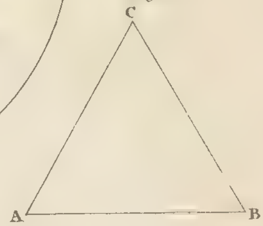


Fig. 5.

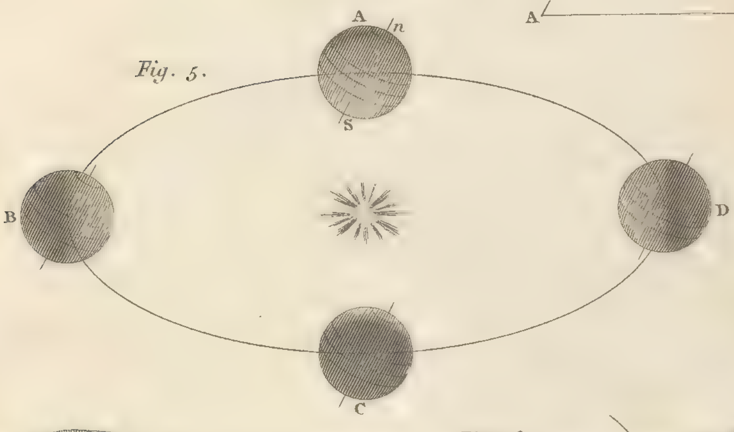
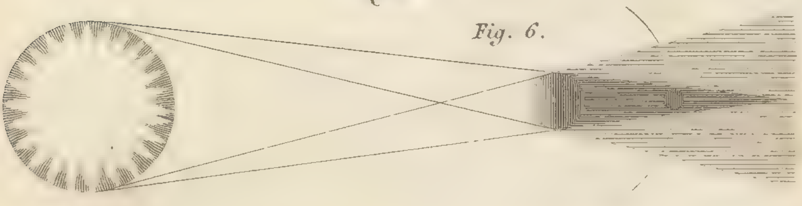


Fig. 6.



Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, Feb.^y 1808.

happens to be in conjunction with the sun, or between the sun and the earth, *viz.* at the time of the new moons, the shadow of the moon falls upon the surface of the earth; hence, properly speaking, such eclipses should be called eclipses of the earth. But the whole disc of the earth cannot be involved in the shadow of the moon, because the moon is much smaller than the earth, and the shadow of the moon is conical. Thus, in Plate III. fig. 1, the rays of the sun, S, being intercepted by the moon, L, form the conical shadow C D G, which falling upon the surface of the earth, entirely deprives that portion of it upon which it falls of the sun's light, and of course the inhabitants of that part of the earth will have a total eclipse of the sun. Beyond the dense conical shadow C D G there is a diverging half shadow, or penumbra C D E F, which is occasioned by the moon's intercepting only a part of the sun's rays from those places which fall within this penumbral cone, and are out of the dense shadow. Thus from the part of the earth Z the portion Y Y B of the sun only can be seen; consequently the inhabitants of that part will have a partial eclipse. As the moon is not always at the same distance from the earth, it sometimes happens that the conical dense shadow does not reach the earth, as in fig. 2, and only the penumbral shadow falls upon it, the eclipse consequently is partial to every part of the earth. Those who are at the centre of the penumbra will lose sight of the centre of the sun by the interposition of the moon's body, which subtending a smaller angle than the sun, will not entirely cover its surface, so that there will be a ring of light all round. The eclipse is then said to be annular. The satellites, or moons, are often eclipsed by the planets to which they belong. The eclipses of Jupiter's moons, as we have already observed, are very useful in ascertaining the longitude. When any of the planetary bodies disappear by another coming before it, it is called an occultation. The occultations of the fixed stars by the moon are of great importance also in determining the longitudes of places.

OF THE TIDES.

The ebbing and flowing of the sea was first shewn by Kepler to be owing to the moon's attraction, and Newton demonstrated it upon the principles of gravitation. The attraction of the moon cannot alter the shape of the solid of the globe: but it has a considerable effect upon the fluid part, which it causes to assume a spheroidal figure, the longest axis being in the direction of the moon. It is therefore the highest tide at that place perpendicularly under the moon, or where the moon crosses the meridian. The sun also has some action upon the waters, though its attraction, on account of its distance, is not so strong as that of the moon. When the action of the sun and moon conspire together the tide rises higher, and produces what are called spring tides. On the contrary, when they counteract each other, they produce neap tides. The ocean, it is well known, covers more than one-half of the globe; and this large body of water is found to be in continual motion, ebbing and flowing alternately without the least intermission. What connection these motions have with the moon we shall see as we proceed; but at present it will be sufficient to observe, that they always follow a certain general rule. For instance, if the tide be now at high-water mark in any port or harbour which lies open to the ocean, it will presently subside, and flow regularly back for about six hours, when it will be found at low-water-mark. After this, it will again gradually advance for six hours, and then return back in the same time to its former situation; rising and falling alternately twice a day, or in the space of about twenty-four hours. And by observing the tides continually at the same place, they will always be found to follow the same rule; the time of high water upon the day of every new moon being nearly at the same hour, and three quarters of an hour later every succeeding day. Let M (fig. 3.) represent the moon, O the centre of ths earth, and A, B, C, &c. different points upon its surface, and let us suppose the earth to be entirely covered by the ocean. Then, because it is the property of a fluid for its parts to yield, and obey any force impressed upon them, it is clear that the moon M, acting upon the surface of the sea at the points A, B, C, &c. will elevate the waters in those parts, and draw them towards her, by her attractive power. But the point A being nearer to the moon than the point C, the attraction at A will be greater than at C; and because the points B and D are at equal distances from the moon, the attraction at those points will also be equal; and so at any other intermediate points the attractive force will be different, according to their different distances from the moon.

From this example then, it is sufficiently evident, that the attractive force of the

moon, acting unequally upon different parts of the ocean, must occasion it to assume a different figure from what it would otherwise have, if there were no such unequal attractions. And since this attractive force is greatest on the part of the ocean which lies immediately under the moon, the waters will of course flow constantly to that part, and be elevated or depressed at different places, according as her situation changes with respect to those places. But, as the earth turns round on its axis, from the moon to the moon again, in about twenty-four hours and three quarters, the flux and reflux will be necessarily retarded from day to day about three quarters of an hour, which is agreeable to experience. It remains now to be explained, why they ebb and flow twice a day, or in the space of about twenty-four hours. When the moon passes the meridian of any place, or is at her greatest height above the horizon of that place, she will evidently attract and elevate the waters which lie immediately under her: but what is the reason, that twelve hours afterwards, when she passes the meridian below the horizon, the waters at the same place are then also elevated? We know, from experience, that, whether the moon be in the zenith or nadir, the phenomenon is nearly the same; it being high water with us at the same time that it is high water with our antipodes.

Let M, (fig. 4.) represent the moon as before; O, the centre of the earth; and Z and N, those parts of the surface which are the nearest to the moon, and the farthest from her. Then because the point Z is nearer to the moon than any other part of the hemisphere H Z R, it is evident that the waters will be more strongly attracted by her, about that point, than at others which are more remote; and since this attraction acts in a contrary direction to that of the earth, the waters in all parts, from H R to Z, must have their gravity or tendency towards the centre O diminished; and as this tendency is the least at the point Z, they will consequently stand higher there than in any other part of the hemisphere. Again in the opposite hemisphere H N R, although the attraction of the moon conspires with that of the earth, yet as it is known to decrease in proportion as the squares of the distances increase, it is plain that the joint influence of the two forces, taken together, will be less at the point N, on the side opposite to the moon, than at those parts which lie nearer to H R, and consequently, as the gravity of the waters, or their tendency towards the centre, is also the least at that point, they will be more elevated there than in any other part of the hemisphere; so that the attractive force of the moon will evidently raise the waters, both at that point of the surface which is nearest to her, and at that which is farthest from her, at the same time, as was to be shewn.

Following this system, then, it is to be observed, that at any port or harbour which lies open to the ocean, the action of the moon will tend to elevate the waters there, when she is on the meridian of that place, whether it be above the horizon or below it. But the water cannot be raised at one place, without flowing from and being depressed at another; and these elevations and depressions will obviously be the greatest at opposite points of the earth's surface. When the moon raises the waters at Z and N, they will be depressed at H and R; and when they are raised by her at H and R, they will be depressed at Z and N. And as the moon passes over the meridian, and is in the horizon twice every day, there will therefore be two tides of flood, and two of ebb, in that time, at the interval of about six hours and eleven minutes each; which is exactly conformable to theory and experience.

From what has been hitherto said, it may be supposed, that the moon is the sole agent concerned in producing the tides. But it will be necessary to observe, before we quit the subject, that the influence of the sun would also produce a similar effect, though in a much less degree, than from his superior magnitude we should naturally be led to imagine. For it is not the entire actions of those bodies upon the whole globe of the earth that is here to be considered, but only the inequalities of those actions upon different parts of it. The whole attractive force of the sun is far superior to that of the moon; but as his distance from the earth is nearly 400 times greater, the forces with which he acts upon different parts of it, will be much nearer to equality than those of the moon; and consequently will have a less effect in producing any change of its figure. For it is to be observed, that if all parts of the earth were equally attracted, they would suffer but little change in their mutual situations. That this doctrine may be still more clearly understood, let it be considered, that though the earth's diameter bears a considerable proportion to the distance of the earth from the moon, yet this diameter is almost nothing when compared to the distance of the earth from the

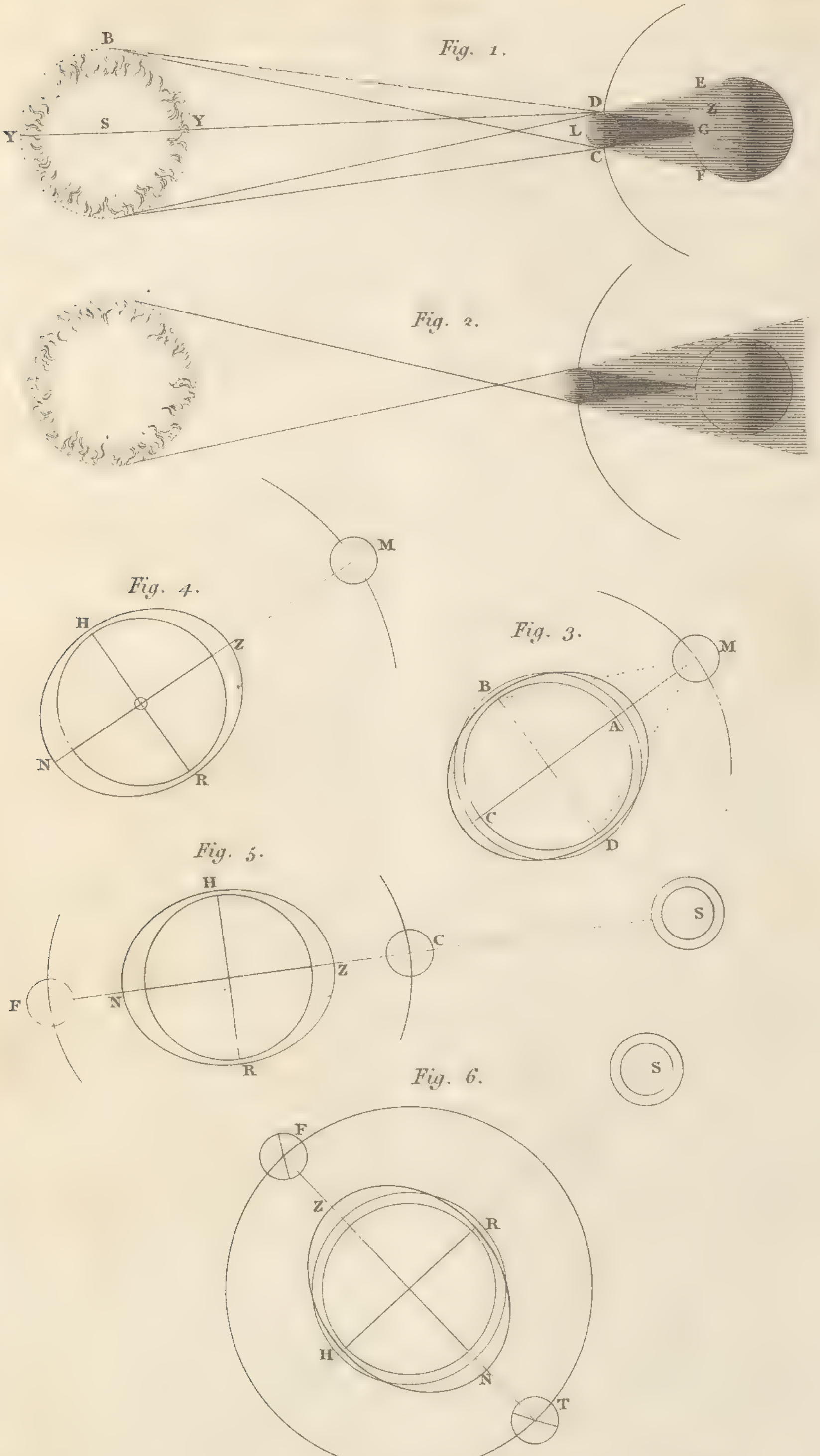


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6.

Lowry sculp.

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sun. The difference of the sun's attraction, therefore, on the sides of the earth under and opposite to him, will be much less than the difference of the moon's attraction on the sides of the earth under and opposite to her; and for this reason, the moon must raise the tides much higher than they can be raised by the sun. Newton calculated the effect of the sun's influence in this case, and found that it is about three times less than that of the moon. The action of the sun alone would therefore be sufficient to produce a flux and reflux of the sea; but the elevations and depressions occasioned by this means would be about three times less than those produced by the moon. The tides, then, are not the sole production of the moon, but of the joint forces of the sun and moon together: or, properly speaking, there are two tides, a solar one, and a lunar one; which have a joint or opposite effect, according to the situation of the bodies which produce them. When the actions of the sun and moon conspire together, as at the time of new and full moon, the flux and reflux become more considerable; and in this case they are called the spring tides. But when one tends to elevate the waters, whilst the other depresses them, as at the moon's first and third quarters, the effect will be exactly the contrary; the flux and reflux, instead of being augmented as before, will now be diminished; and they are then called the neap tides. But as this is a matter of some importance, it may be worth while to enter into a more minute explanation of it.

For this purpose, let S (fig. 5) represent the sun, Z H N R the earth, and F C the moon at her full and change. Then, because the sun S, and the moon C, are nearly in the same right line with the centre of the earth O, their actions will conspire together, and raise the water about the zenith Z, or the point immediately under them, to a greater height than if only one of these forces acted alone. But it has been shewn, that when the ocean is elevated at the zenith Z, it is also elevated at the opposite point, or nadir, N, at the same time; and, therefore, in this situation of the sun and moon, the tides will be augmented. Again, whilst the full moon F raises the waters at N and Z, directly under and opposite to her, the sun, S, acting in the same right line, will also raise the waters at the same points, Z and N, directly under and opposite to him; and therefore, in this situation also, the tides will be augmented; their joint effect being nearly the same at the change as at the full; and in both cases they occasion what are called the spring tides. Pursuing the illustration in the same way, let now F and T (fig. 6) be the moon in her first and third quarters, and the rest as before. Then, since the sun and moon act in the right lines S H and F T, which are nearly perpendicular to each other, their forces will tend to produce contrary effects; because the one raises the waters in that part where the other depresses them. The sun's attraction at R and H, will diminish the effect of the moon's attraction at Z and N; so that the waters will rise a little at the points under and opposite to the sun, and fall as much at the points under and opposite to the moon; and of course the lunar tides will be diminished in those parts. This respects the moon only in her first quarter, at F; but the same reasoning will evidently hold, when applied to the moon in her third quarter at T; for as the sun and moon still act in lines which are perpendicular to each other, they must produce the same diminution as before; and in both these cases they occasion what are called the neap tides. But it must be observed, that neither the spring nor neap tides happen when the sun and moon have the precise situations here mentioned; because, in this case, as in others of a similar kind, the actions do not produce the greatest effect when they are the strongest, but some time afterwards. The effects of the disturbing forces of the sun and moon, depend likewise upon their respective distances from the earth, as well as upon their particular situations. For the less the distances are, the greater will be their effects; and, consequently, in winter, when the sun is nearer to the earth, the spring tides will be greater than in summer, when he is farther off; and the neap tides, on that account, will be less. For a like reason, as the moon moves in an elliptical orbit round the earth, and is nearer to us at some times than at others, the tides will at those times be greater, and at the opposite points of her orbit, less. Some variations likewise take place in consequence of the different declinations of the sun and moon at different times. For if either of these luminaries were at the pole, it would occasion a constant elevation both there and at the opposite one, and a constant depression at the equator; so that as the sun and moon gradually decline from the equator, they lose their effect, and the tides become less; and when they are both in the equator, the tides of course become greater.

Astronomy is sometimes divided in books, with respect to its different states, into "new" and "old." The former refers to the art as it stood under Ptolemy and his followers, with all the apparatus of solid orbs, epicycles, &c. &c. By new astronomy is meant the science as it has been cultivated since the period in which Copernicius flourished. By that great man the constitution of the heavens was reduced to more simple, natural, and certain principles. The substance of the old astronomy is given by Tacquet, and of the new by Whiston, in his "Prelectiones Astronomicæ, published in 1707. The whole doctrine, both according to the ancients and moderns, is explained by Mercator in his Institutiones Astron.

Having concluded this brief sketch of a very important science, we shall refer to other articles, in which many subjects will be discussed, that usually find place in a treatise of astronomy. Under the word SUN will be found some interesting speculations of Dr. Herschel; under that of MOON, an account of the methods of measuring its mountains, an explication of the harvest moon and horizontal moon. For *equation of time*, see TIME; see also EARTH, *figure of;* ECLIPTIC; EQUINOXES, *precession of*; GALAXY; GRAVITATION; NEBULÆ; SATURN, *ring of;* ASTRONOMY, *practical;* and ASTONOMICAL *instruments;* see OBSERVATORY; SATELLITES; TRANSIT; &c. &c. &c.

ASTROSCOPE, an instrument composed of two cones, having the constellations delineated on their surfaces, whereby the stars may be easily known.

ASYMETRY, in a general sense, the want of proportion between the parts of any thing, being the contrary of symmetry.

In mathematics it is used for what is more commonly called incommensurability, or the relation of two quantities which have no common measure, as between one and the square root of two, or as $1 : \sqrt{2}$, or the side and diagonal of a square.

ASYMPTOTE, in geometry, a line which continually approaches nearer to another; but, though continued infinitely, will never meet with it: of these there are many kinds.

The term asymptotes is appropriated to right lines, which approach nearer and nearer to some curve, of which they are said to be the asymptotes; but if they and their curves are indefinitely continued they will never meet.

Concerning asymptotes and asymptotical curves, it may be remarked, 1. That although such curves as have asymptotes are of the number of those which do not include a space; yet it is not true, on the other hand, that wherever we have a curve of that nature, we have an asymptote also. 2. Of these curves that have an asymptote, some have only one, as the conchoid, cissoid, and logarithmic curve; and others two, as the hyperbola. 3. As a right line and a curve may be asymptotical to one another, so also may curves and curves: such are two parabolas, whose axes are in the same right line. 4. No right line can ever be an asymptote to a curve that is every where concave to that right line. 5. But a right line may be an asymptote to a mixed curve, that is partly concave, and partly convex, towards the same line. And, 6. All curves that have one and the same common asymptote, are also asymptotical to one another. See CONIC SECTIONS.

ASYNDETON, in grammar, a figure which omits the conjunctions in a sentence, as in that verse of Virgil.

Ferte citi flammas, date vela, impellite remos.

ATCHIEVEMENT, in heraldry, denotes the arms of a person, or family, together with all the exterior ornaments of the shield, as helmet, mantle, crest, scrolls, and motto, with such quarterings as may have been acquired by alliances, all marshalled in order.

ATHAMANTA, in botany, a genus of the Pentandria Digynia class of plants, the general corolla whereof is uniform; the partial one consists of five inflexo-cordated unequal petals: there is no pericarpium; the fruit is ovato-oblong, striated, and divisible into two parts; the seeds are two, oval, striated, and convex on the one side, and plane on the other. There are 10 species.

ATHANASIA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order, and of the natural order of compound flowers. The essential character is calyx imbricate; down chaffy, very short; receptacle chaffy. There are 20 species.

ATHEIST, is one who does not believe in the existence of a God. He attributes every thing to a fortuitous concourse of atoms. Plato distinguishes three sorts of Atheists. 1. Such as deny absolutely that there any gods. 2. Others who allow their existence, but deny that they have any concern with human affairs; and lastly, such as believe in gods and a providence, but think they are easily appeased, and remit the greatest of crimes for the smallest supplica-

tion. The first of these are the only true Atheists, and it has been doubted whether such persons really exist; yet it must be confessed, that in the year 1619, Spinosa was burnt to death for having avowed his adherence to the opinion. We have many excellent works in opposition to Atheism, but not a single treatise written in its behalf. Those who wish to see Atheism confuted, may be referred to the sermons preached at Boyle's Lectures; to Abernethy's Discourses on the Attributes; and above all to Paley's Natural Theology. Newton, Boyle, Maclaurin, and others, among the most distinguished mathematicians and philosophers, have been among the ablest advocates for the existence of a God.

ATHENÆA, in botany, a genus of plants of the Octandria Monogynia class and order. Essential character: calyx coloured, five-parted; no corolla; bristles eight-feathered, between the filaments; stigma five-parted; capsule globose, one-celled, three-valved; seeds three to five. There is one species, a branching shrub; stem four or five inches in diameter, covered with a wrinkled grey bark. The flowers came out in bundles from the axils; their calyx is white; capsule green, with a tinge of violet. The seeds are covered with a pulpy viscid membrane, of a scarlet colour; the bark, leaves, and fruits are sharp and aromatic. The last are called by the Creoles *caffé diable*. It is a native of Cayenne and the neighbouring continent of Guiana, a mile from the shore, in a sandy soil, flowering and bearing fruit in September.

ATHENÆUM, in antiquity, a public place wherein the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances.

ATHERINA, in natural history, a genus of fishes of the order Abdominales. Head somewhat flattened over the upper-jaw; gill-membrane six-rayed; body marked by a silver lateral stripe. There are five species: A. hespetus has an anal fin with about twelve rays; it inhabits the Mediterranean, European, and Red seas; about three or four inches long; body varied with a few black spots, and nearly pellucid. This species, which is named Athernos by the modern Greeks, is seen in vast shoals about the coasts of the islands in the Archipelago, and is easily taken in great quantities by the simple device of trailing in the water a horse's tail or a piece of black-cloth fastened to the end of a pole, the fishes following all its motions, and suffering themselves to be drawn into some deep cavity formed by the rocks, when they are readily secured by means of a net, and may be taken at pleasure. At Southampton they are to be had at almost all seasons, where they go by the name of smelts. See Plate Pisces, fig. 4.

ATHWART, in naval affairs, across the line of the ship's course, as "We discovered a fleet standing athwart us," *i. e.* steering across our way.

ATHWART *hawse*, the situation of a ship when she is driven by any accident across the stem of another, whether they bear against, or at a small distance from each other: the transverse position being principally understood.

ATLAS, in matters of literature, denotes a book of universal geography, containing maps of all the known parts of the world.

ATLAS, in commerce, a silk-satin, manufactured in the East Indies. There are some plain, some striped, and some flowered; the flowers of which are either gold or silk. There are atlases of all colours, but most of them false, especially the red and the crimson. The manufacture of them is admirable, the gold and silk being worked together after such a manner, as no workman in Europe can imitate; yet they are very far from having that fine gloss and lustre which the French know how to give their silk stuffs. In the Chinese manufactures of this sort, they gild paper on one side with leaf-gold, then cut it in long slips, and weave it into their silks, which makes them, with very little cost, look very rich and fine. The same slips are twisted or turned about silk threads so artificially, as to look finer than gold thread, though it be of no greater value.

ATMOSPHERE is that invisible elastic fluid which surrounds the earth to an unknown height, and encloses it on all sides. This fluid is essential to the existence of all animal and vegetable life, and even to the constitution of all kinds of matter whatever, without which they would not be what they are: for by it we literally may be said to live, move, and have our being: by insinuating itself into all the pores of bodies, it becomes the great spring of almost all the mutations to which the chemist and philosopher are witnesses in the changes of bodies. Without the atmosphere no animal could exist; vegetation would cease, and there would be neither rain nor refreshing dews to moisten the face of the ground; and though the sun and stars might be seen as bright specks, yet there would be little enjoyment of light,

could we ourselves exist without it. Nature indeed, and the constitutions and principles of matter, would be totally changed if this fluid were wanting.

The mechanical force of the atmosphere is of great importance in the affairs of men, who employ it in the motion of their ships, in turning their mills, and in a thousand other ways connected with the arts of life. It was not till the time of Lord Bacon, who taught his countrymen how to investigate natural phenomena, that the atmosphere began to be investigated with any degree of precision. Galileo introduced the study by pointing out its weight; a subject that was soon after investigated more completely by Torricelli and others. Its density and elasticity were ascertained by Mr. Boyle and the academicians at Florence. Mariotte measured its dilatibility; Hooke, Newton, Boyle, and Derham, shewed its relation to light, to sound, and to electricity. Sir I. Newton explained the effect produced upon it by moisture, from which Halley attempted to explain the changes in its weight indicated by the barometer.

The atmosphere, we have said, envelops the whole surface of the earth, and if they were both at rest, then the figure of the atmosphere would be globular, because all the parts of the surface of a fluid in a state of rest must be equally removed from its centre. But as the earth and the surrounding parts of the atmosphere revolve uniformly together about their axis, the different parts of both have a centrifugal force, the tendency of which is more considerable, and that of the centripetal less, as the parts are more remote from the axis, and hence the figure of the atmosphere must become an oblate spheroid, since the parts that correspond to the equator are farther removed from the axis than the parts which correspond to the poles. The figure of the atmosphere must also, on another account, represent a flattened spheroid, namely, because the sun strikes more directly the air which encompasses the equator, and is comprehended between the two tropics, than that which pertains to the polar regions: hence it follows, that the mass of air, or part of the atmosphere adjoining to the poles, being less heated, cannot expand so much nor reach so high. Nevertheless, as the same force which contributes to elevate the air diminishes its gravity and pressure on the surface of the earth, higher columns of it about the equatorial parts, other circumstances being the same, may not be heavier than those about the poles. Mr. Kirwan observes, that in the natural state of the atmosphere, that is, when the barometer would, every where at the level of the sea, stand at 30 inches, the weight of the atmosphere at the surface of the sea must be equal all over the globe; and in order to produce this equality, as the weight proceeds from its density and height, it must be lowest where the density is greatest, and highest where the density is least, that is, highest at the equator and lowest at the poles, with the intermediate gradations. On this and other accounts, in the highest regions of the atmosphere, the denser equatorial air not being supported by the collateral tropical columns, gradually flows over and rolls down to the north and south; these superior tides have been supposed to consist of hydrogen gas, inasmuch as it is much lighter than any other, and is generated in great plenty between the tropics; it is also supposed to furnish the matter of the auroræ borealis and australis.

With regard to the weight and pressure of the atmosphere, it is evident that the whole mass, in common with all other matter, must be endowed with weight and pressure: and it is found by undeniable experiments, that the pressure of the atmosphere sustains a column of quicksilver in the tube of a barometer of about 30 inches in height; it accordingly follows, that the whole pressure of the atmosphere is equal to the weight of a column of quicksilver of an equal base, and 30 inches in height, or the weight of the atmosphere on every square inch of surface is equal to 15 pounds. It has moreover been found, that the pressure of the atmosphere balances, in the case of pumps, &c. a column of water $34\frac{1}{2}$ feet high; and the cubical foot of water weighing just 1000 ounces, or $62\frac{1}{2}$ pounds, $34\frac{1}{2}$ multiplyed by $62\frac{1}{2}$, or 2158 *lb.* will be the weight of a column of water, or of the atmosphere on the base of a square foot; and consequently the 144th part of this, or 15 *lb.* is the weight of the atmosphere on a square inch. From these data, Mr. Cotes computed the pressure of the atmosphere on the whole surface of the earth to be equivalent to that of a globe of lead 60 miles in diameter. Dr. Vince and others have given the weight at 77670297973563429 tons. This weight is however variable; it sometimes being much greater than at others. If the surface of a man, for instance, be equal to $14\frac{1}{2}$ square feet, the pressure upon him, when the atmosphere is in its lightest state, is equal to $13\frac{1}{2}$ tons, and when in the heaviest, it is about 14 tons and one-third*; the difference of which is about 2464 *lb.* It is surprizing that such weights should be able

to be borne without crushing the human frame: this indeed must be the case, if all the parts of our body were not endowed with some elastic spring, whether of air or other fluid, sufficient to counterbalance the weight of the atmosphere. Whatever this spring is, it is certain that it is just able to counteract the weight of the atmosphere, and no more; of course it must alter in its force as the density of the atmosphere varies: for if any considerable pressure be superadded to that of the air, as by going into deep water, it is always severely felt; and if, on the other hand, the pressure of the atmosphere be taken off from any part of the human body, by means of the apparatus belonging to the air pump, the inconvenience is immediately perceived.

The difference in the weight of the atmosphere is very considerable, as has been observed, from the natural changes in the state of the air. These changes take place chiefly in countries at a distance from the equator. In Great Britain, for instance, the barometer varies from 28.4 to 30.7. On the increase of this natural weight, the weather is commonly clear and fine, and we feel ourselves alert and active; but when the weight of the air diminishes, the weather is often bad, and we feel listlessness and inactivity. Hence invalids suffer in their health from very sudden changes in the atmosphere. In our observations on the barometer, we have known the mercury to vary a full inch, or even something more, in the course of a few hours. Such changes, however, are by no means frequent. Ascending to the tops of mountains, where the pressure of the air is very much diminished, the inconvenience is rarely felt, on account of the gradual change; but when a person ascends in a balloon with great rapidity, he feels, we are told by Garnerin and other aeronauts, a difficulty of breathing, and many unpleasant sensations. So also, on the condensation of the air, we feel little or no alteration in ourselves, except when the variations are sudden in the state of the atmosphere, or by those who descend to great depths in a diving-bell. See DIVING-BELL.

It is not easy to assign the true reason for the changes that happen in the gravity of the atmosphere in the same place. One cause is, undoubtedly, the heat of the sun; for where this is uniform, the changes are small and regular. Thus, between the tropics the barometer constantly sinks about half an inch every day, and rises to its former station in the night. But in the temperate zones, the altitude of the mercury is subject to much more considerable variations, as we have seen with respect to what is observable in our own country.

As to the alteration of heat and cold, Dr. Darwin infers, that there is good reason to conclude that in all circumstances where air is mechanically expanded, it becomes capable of attracting the fluid matter of heat from other bodies in contact with it. Now, as the vast region of air which surrounds our globe is perpetually moving along its surface, climbing up the sides of mountains, and descending into the valleys; as it passes along it must be perpetually varying the degree of heat according to the elevation of the country it traverses: for, in rising to the summits of mountains, it becomes expanded, having so much of the pressure of the superincumbent atmosphere taken away; and when thus expanded, it attracts or absorbs heat from the mountains in contiguity with it; and, when it descends into the valleys and is compressed into less compass, it again gives out the heat it has acquired to the bodies it comes in contact with. The same thing must happen in the higher regions of the atmosphere, which are regions of perpetual frost, as has lately been discovered by the aerial navigators. When large districts of air, from the lower parts of the atmosphere, are raised two or three miles high, they become so much expanded by the great diminution of the pressure over them, and thence become so cold, that hail or snow is produced by the precipitation of the vapour: and as there is, in these high regions of the atmosphere, nothing else for the expanded air to acquire heat from after it has parted with its vapour, the same degree of cold continues till the air, on descending to the earth, acquires its former state of condensation and of warmth. The Andes, almost under the line, rests its base on burning sands: about its middle height is a most pleasant and temperate climate covering an extensive plain, on which is built the city of Quito; while its forehead is encircled with eternal snow, perhaps coeval with the mountain. Yet, according to the accounts of Don Ulloa, these three discordant climates seldom encroach much on each other's territories. The hot winds below, if they ascend, become cooled by their expansion; and hence they cannot affect the snow upon the summit; and the cold winds that sweep the summit, become

condensed as they descend, and of temperate warmth before they reach the fertile plains of Quito.

Various attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered by means of the Torricellian tube, that air is endued with weight and pressure. And had not the air an elastic power, but were it every where of the same density, from the surface of the earth to the extreme limit of the atmosphere, like water, which is equally dense at all depths, it would be a very easy matter to determine its height from its density and the column of mercury which it would counterbalance in the barometer tube: for, it having been observed that the weight of the atmosphere is equivalent to a column of 30 inches or $2\frac{1}{2}$ feet of quicksilver, and the density of the former to that of the latter, as 1 to 11040; therefore the height of the uniform atmosphere would be 11040 times $2\frac{1}{2}$ feet, that is 27600 feet, or little more than 5 miles and a quarter. But the air, by its elastic quality, expands and contracts; and it being found by repeated experiments in most nations of Europe, that the spaces it occupies, when compressed by different weights, are reciprocally proportional to those weights themselves; or, that the more the air is pressed, so much the less space it takes up; it follows that the air in the upper regions of the atmosphere must grow continually more and more rare, as it ascends higher; and indeed that, according to that law, it must necessarily be extended to an indefinite height. Now, if we suppose the height of the whole divided into innumerable equal parts; the quantity of each part will be as its density; and the weight of the whole incumbent atmosphere being also as its density; it follows, that the weight of the incumbent air is every where as the quantity contained in the subjacent part; which causes a difference between the weights of each two contiguous parts of air. But, by a theorem in arithmetic, when a magnitude is continually diminished by the like part of itself, and the remainders the same, these will be a series of continued quantities decreasing in geometrical progression: therefore if, according to the supposition, the altitude of the air, by the addition of new parts into which it is divided, do continually increase in arithmetical progression, its density will be diminished, or, which is the same thing, its gravity decreased, in continued geometrical proportion. And hence, again, it appears that, according to the hypothesis of the density being always proportional to the compressing force, the height of the atmosphere must necessarily be extended indefinitely. And, farther, as an arithmetical series adapted to a geometrical one, is analogous to the logarithms of the said geometrical one; it follows therefore that the altitudes are proportional to the logarithms of the densities, or weights of air; and that any height taken from the earth's surface, which is the difference of two altitudes to the top of the atmosphere, is proportional to the difference of the logarithms of the two densities there, or to the logarithm of the ratio of those densities, or their corresponding compressing forces, as measured by the two heights of the barometer there.

It is now easy, from the foregoing property, and two or three experiments, or barometrical observations, made at known altitudes, to deduce a general rule to determine the absolute height answering to any density, or the density answering to any given altitude above the earth. And accordingly, calculations were made upon this plan by many philosophers, particularly by the French; but it having been found that the barometrical observations did not correspond with the altitudes as measured in a geometrical manner, it was suspected that the upper parts of the atmospherical regions were not subject to the same laws with the lower ones, in regard to the density and elasticity. And indeed, when it is considered that the atmosphere is a heterogeneous mass of particles of all sorts of matter, some elastic, and others not, it is not improbable but this may be the case, at least in the regions very high in the atmosphere, which it is likely may more copiously abound with the electrical fluid. Be this however as it may, it has been discovered that the law above given, holds very well for all such altitudes as are within our reach, or as far as to the tops of the highest mountains on the earth, when a correction is made for the difference of the heat or temperature of the air only, as was fully evinced by M. De Luc, in a long series of observations, in which he determined the altitudes of hills both by the barometer, and by geometrical measurement, from which he deduced a practical rule to allow for the difference of temperature. Similar rules have also been deduced from accurate experiments, by Sir George Shuck-

burgh and General Roy, both concurring to shew, that such a rule for the altitudes and densities holds true for all heights that are accessible to us, when the elasticity of the air is corrected on account of its density: and the result of their experiments shewed, that the difference of the logarithms of the heights of the mercury in the barometer, at two stations, when multiplied by 10000, is equal to the altitude in English fathoms, of the one place above the other; that is, when the temperature of the air is about 31 or 32 degrees of Fahrenheit's thermometer; and a certain quantity more or less, according as the actual temperature is different from that degree.

But it may be shewn, that the same rule may be deduced independent of such a train of experiments as those referred to, merely by the density of the air at the surface of the earth. Thus, let D denote the density of the air at one place, and d the density at the other; both measured by the column of mercury in the barometrical tube: then the difference of altitude between the two places, will be proportional to the log. of D — the log. of d, or to the log. of $\frac{D}{d}$. But as this formula expresses only the relation between different altitudes, and not the absolute quantity of them, assume some indeterminate, but constant quantity h, which multiplying the expression log. $\frac{D}{d}$, may be equal to the real difference of altitude a, that is, $a = h \times$ log. of $\frac{D}{d}$. Then, to determine the value of the general quantity h, let us take a case in which we know the altitude a that corresponds to a known density d; as for instance, taking $a = 1$ foot, or 1 inch, or some such small altitude: then because the density D may be measured by the pressure of the whole atmosphere, or the uniform column of 27600 feet, when the temperature is 55°; therefore 27600 feet will denote the density D at the lower place, and 27599 the less density d at 1 foot above it; consequently $1 = h \times$ log. of $\frac{27600}{27599}$, which by the nature of logarithms, is nearly $= h \times \frac{.43429448}{27600}$ or $\frac{1}{63551}$ nearly; and hence we find $h = 63551$ feet; which gives us this formula for any altitude a in general, *viz.* $a = 63551 \times$ log. of $\frac{D}{d}$, or $a = 63551 \times$ log. of $\frac{M}{m}$ feet, or $10592 \times$ log. of $\frac{M}{m}$ fathoms; where M denotes the column of mercury in the tube at the lower place, and m that at the upper. This formula is adapted to the mean temperature of the air 55°: but it has been found, by the experiments of Sir George Shuckburgh and General Roy, that for every degree of the thermometer, different from 55°, the altitude a will vary by its 435th part; hence, if we would change the factor h from 10592 to 10000, because the difference 592 is the 18th part of the whole factor 10592, and because 18 is the 24th part of 435; therefore the change of temperature, answering to the change of the factor h, is 24°, which reduces the 55° to 31°. So that, $a = 10000 \times$ log. of $\frac{M}{m}$ fathoms, is the easiest expression for the altitude, and answers to the temperature of 31°, or very nearly the freezing point: and for every degree above that, the result must be increased by so many times its 435th part, and diminished when below it.

From this theorem it follows, that, at the height of $3\frac{1}{2}$ miles, the density of the atmosphere is nearly 2 times rarer than it is at the surface of the earth; at the height of 7 miles, 4 times rarer; and so on, according to the following table:

Height in miles.	Number of times rarer.
$3\frac{1}{2}$	2
7	4
14	16
21	64
28	256
35	1024
42	4096
49	16384
56	65536
63	262144
70	1048576

And, by pursuing the calculations in this table, it might be easily shewn, that a cubic inch of the air we breathe would be so much rarefied at the height of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

It has been observed above, that the atmosphere has a refractive power, by which the rays of light are bent from the right lined direction, as in the case of the twilight;

and many other experiments manifest the same virtue, which is the cause of many phenomena. Alhazen, the Arabian, who lived about the year 1100, it seems was more inquisitive into the nature of refraction than former writers. But neither Alhazen, nor his follower Vitello, knew any thing of its just quantity, which was not known, to any tolerable degree of exactness, till Tycho Brahe, with great diligence, settled it. But neither did Tycho nor Kepler discover in what manner the rays of light were refracted by the atmosphere. Tycho thought the refraction was chiefly caused by dense vapours, very near the earth's surface: while Kepler placed the cause wholly at the top of the atmosphere, which he thought was uniformly dense; and thence he determined its altitude to be little more than that of the highest mountains. But the true constitution of the density of the atmosphere, deduced afterwards from the Torricellian experiment, afforded a juster idea of these refractions, especially after it was found, that the refractive power of the air is proportional to its density. By this variation in the density and refractive power of the air, a ray of light, in passing through the atmosphere, is continually refracted at every point, and thereby made to describe a curve, and not a straight line, as it would have done were there no atmosphere, or were its density uniform.

The atmosphere, or air, has also a reflective power; and this power is the means by which objects are enlightened so uniformly on all sides. The want of this power would occasion a strange alteration in the appearance of things; the shadows of which would be so very dark, and their sides enlightened by the sun so very bright, that probably we could see no more of them than their bright halves; so that for a view of the other halves, we must turn them half round, or if immoveable, must wait till the sun could come round upon them. Such a pellucid unreflective atmosphere would indeed have been very commodious for astronomical observations on the course of the sun and planets among the fixed stars, visible by day as well as by night; but then such a sudden transition from darkness to light, and from light to darkness, immediately upon the rising and setting of the sun, without any twilight, and even upon turning to or from the sun at noon day, would have been very inconvenient and offensive to our eyes. However, though the atmosphere be greatly assistant in the illumination of objects, yet it must also be observed that it stops a great deal of light.

The knowledge of the component parts of the atmosphere is among the discoveries of the moderns. The opinions of the earlier chemists were too vague to merit any particular notice. Boyle, however, and his contemporaries, put it beyond doubt that the atmosphere contained two distinct substances, *viz.* an elastic fluid, distinguished by the name of air, and water in the state of vapour. Besides these two bodies, it was supposed that the atmosphere contained a great variety of other substances, which were continually mixing with it from the earth, and which often altered its properties, and rendered it noxious or fatal. Since the discovery of carbonic acid gas by Dr. Black, it has been ascertained that this elastic fluid always constitutes a part of the atmosphere. The constituent parts of the atmosphere are, according to Mr. Murray,

	By measure.	By weight.
Nitrogen gas	77.5	75.55
Oxygen gas	21.0	23.32
Aqueous vapour	1.42	1.03
Carbonic acid gas	.08	.10
	100.00	100.00

It has been imagined that a portion of hydrogen may exist in the atmospheric air. But in the usual analysis of it oxygen is abstracted, and the residual air is found to be nitrogen. The nitrogen is probably not perfectly pure, and it is possible a small portion of hydrogen is mixed with it, which, from the quantity being very trifling, is difficult to be detected.

The properties of atmospheric air appear to be merely the aggregated properties of the gases of which it consists. It is invisible, inodorous, insipid, compressible, and permanently elastic. It supports combustion, and as it does so from the oxygen it contains, the combustion is less rapid and vivid, and continues for a shorter time. By the same agency it supports animal life; a portion of its oxygen is consumed in respiration, and from some experiments of Mr. Davy, there appears to be a consumption of a very small portion of its nitrogen. Atmospheric air is very sparingly absorbed by water; and the absorption is unequal, more of the oxygen

being combined with the water than of the nitrogen. It is difficult, even by long boiling, to expel from water the whole of the oxygen which it holds dissolved; and, if exposed again to the atmosphere, it very quickly imbibes it.

Atmospheric air is an important agent in many of the operations of nature. Besides serving as the vehicle of the distribution of water, it is, by its mobility, the great agent by which temperature is in some measure equalized, or at least its extremes moderated. Animals, as we have seen, are dependent on it for life. It is essential to respiration; in the more perfect animals its deprivation cannot be sustained for a few moments; and even in the less perfect, the abstraction of it is followed, though not so immediately, by death. Its agency depends chiefly on its oxygen, a quantity of which is spent in every inspiration in producing chemical changes in the blood. A part of its nitrogen also is consumed, while a portion of carbonic acid gas is formed and expired. Vegetable life is also in part dependent on it; it conveys water, and perhaps carbonic acid gas, and other principles, to the leaves of plants, and is thus subservient to their nutrition and growth.

ATOMICAL *philosophy* denotes the doctrine of atoms, or a method of accounting for the origin and formation of all things from the supposition of atoms endued with gravity and motion. The atomic physiology, according to the account given of it by Dr. Cudworth, supposes that body is nothing else but an extended bulk; and resolves, therefore, that nothing is to be attributed to it but what is included in the nature and idea of it, *viz.* more or less magnitude, with divisibility into parts, figure, and position, together with motion or rest; but so as that no part of body can ever move itself, but is always moved by something else. And consequently it supposes that there is no need of any thing else besides the simple elements of magnitude, figure, site, and motion, which are all clearly intelligible as different modes of extended substance to solve the corporeal phenomena by; and, therefore, not of any substantial forms distinct from the matter, nor of any other qualities really existing in the bodies without, besides the results or aggregates of those simple elements, and the disposition of the insensible parts of bodies in respect of figure, site, and motion, nor of any intentional species or shews, propagated from the objects to our senses; nor, lastly, of any other kind of motion or action really distinct from local motion, such as generation and alteration, they being neither intelligible as modes of extended substance, nor any ways necessary. Forasmuch as the forms and qualities of bodies may well be conceived to be nothing but the result of those simple elements of magnitude, figure, site, and motion, variously combined together in the same manner as syllables and words, in great variety, result from the different combinations and conjunctions of a few letters, or the simple elements of speech; and the corporeal part of sensation, particularly that of vision, may be solved only by local motion of bodies, that is, either by corporeal effluvia streaming continually from the surface of the objects, or rather, as the later and more refined atomists conceived, by pressure made from the object to the eye, by means of light in the medium. So that the sense taking cognizance of the object by the subtle interposed medium, that is tense and stretched, (thrusting every way from it upon the optic nerves) doth by that as it were by a staff touch it. Again, generation and corruption may be sufficiently explained by concretion and secretion, or local motion, without substantial forms and qualities. And, lastly, those sensible ideas of light and colours, heat and cold, sweet and bitter, as they are distinct things from the figure, site, and motion of the insensible parts of bodies, seem plainly to be nothing else but our own fancies, passions, and sensations; however, they be vulgarly mistaken for qualities in the bodies without us.

ATRA *bilis*, in ancient medicine, the black bile, one of the humours of the ancient physicians; which the moderns call melancholy. Dr. Percival suggests that this disorder is occasioned by the stagnation of the gall, by which it is rendered too viscid by the absorption of its fluid parts. Bile in this state discharged into the duodenum occasions universal disturbance until it be evacuated. It brings on vomiting, purging, &c. previous to which are fever, delirium, &c.

ATRACTYLIS, in botany, a genus of the Syngenesia Polygamia class of plants, with radiated flowers and compressed seeds, coronated with a plumose down, and standing on a plane villose receptacle. There are eight species, of which we may notice the A. gummifera, gummy-rooted attractylis; root perennial, sending out many narrow leaves which are deeply sinuated, and armed with spines on the edges; these lie

close on the ground, and between them the flower is situated; it is a native of Italy and the islands of the Archipelago. It flowers in July, but the seeds never come to perfection in England.

ATRAGENE, in botany, a genus of the Polyandria Polygynia class of plants, the flower of which consists of twelve petals, and its seeds are caudated. There are five species. This genus is allied to Ranunculus, but has a double row of petals, in the outer row four large ones, in the inner many small ones, which are properly nectaries. The A, alpina may be increased by cuttings or layers, in the same manner as clematis; in a strong soil, and trained against a wall it will rise to the height of six or eight feet. The flowers appear early, and if the season prove favourable they make a handsome figure; but as this plant is apt to put out leaves very early in the spring it is frequently nipped by the frosts; as are many plants and trees of Siberia and Tartary of which this is a native.

ATRAPHAXIS, in botany, a genus of the Hexandria Digynia class of plants, the flower of which consists of two roundish, sinuated, and permanent petals; and its cup incloses a single, roundish, and compressed seed. There are two species: 1. the spinosa, a shrub that rises four or five feet high, sending out many weak lateral branches, armed with spines, and garnished with small ash-coloured leaves. The flowers come out at the ends of the shoots in clusters, each consisting of two white petals tinged with purple, included in a two-leaved calyx of a white herbaceous colour. 2. A. undulata, which sends out many slender branches, trailing on the ground; leaves about the size of those of knot-grass, waved and curled on their edges, embracing the stalk half round at their base. This is a native of the Cape.

ATRIPLEX, *orach*, in botany, a genus of the Polygamia Monoecia class of plants, without any flower petals; the cup of the female flower is composed of two leaves, inclosing a single and compressed seed; whereas that of the hermaphrodite flower is composed of five leaves, and incloses a single, roundish, and depressed seed. There are fourteen species.

ATROPA, in botany, a genus of the Pentandria Monogynia class of plants, the flower of which consists of a single funnel-fashioned petal; the fruit is a globose berry containing two cells, wherein the seeds inclosed are numerous and kidney-shaped. There are eight species, of which we notice in this place the A. belladonna, deadly night-shade, which has a perennial, thick, long, and branching root, sending out strong, herbaceous, upright, branching stems; the root-leaves are often a foot long, and five inches broad; peduncles axillary, one-flowered; flowers large, nodding, void of scent; calyx green; berry large, at first green, but when ripe of a beautiful shining black colour, full of purple juice; with roundish, dotted, channelled seeds, immersed in the pulp, and a glandular ring surrounding it. It is a native of Europe, particularly of Austria and England, in church-yards and on dunghills, skulking in gloomy lanes and uncultivated places; in other countries it is said to be common in woods and hedges. The qualities of this plant are malignant, and it is extremely poisonous in all its parts. Numerous instances have occurred of the berries proving fatal after causing convulsions and delirium. Buchanan relates the destruction of the army of Sweno the Dane, when he invaded Scotland, by the berries of this plant, which were mixed with the drink with which the Scots had engaged to supply the Danes. The invaders became so inebriated that the Scottish army fell on them in their sleep and slew such numbers that scarcely enough were left to carry off their king. To children the berries have often been fatal. The symptoms occur in half an hour, and consist of vertigo, great thirst, delirium, swelling, and redness of face. Vinegar liberally drank has been found efficacious in obviating the effects of the poison. See MANDRAKE.

ATROPHY, in medicine, a disease wherein the body or some of its parts do not receive the necessary nutriment, but waste and decay incessantly. See MEDICINE.

ATTACHING, or ATTACHMENT, in law, the taking or apprehending of a person by virtue of a writ or precept.

It is distinguished from an arrest in this respect, that whereas an arrest lies only on the body of a man, an attachment is oftentimes on the goods only, and sometimes on the body and goods; there is this farther difference, that an arrest proceeds out of an inferior court by precept only, and an attachment out of a higher court, either by precept or writ.

An attachment by writ differs from distress, insomuch that an attachment does not extend to lands, as a distress does; and a

distress does not touch the body as an attachment does.

In the common acceptation, an attachment is the apprehension of a man's body, to bring him to answer the action of the plaintiff.

ATTACHMENT *out of the chancery* is obtained upon an affidavit made that the defendant was served with a subpœna, and made no appearance; or it issueth upon not performing some order or decree. Upon the return of this attachment by the sheriff, *quod non est inventus in balliva sua*, another attachment, with a proclamation, issues; and if he appears not thereupon, a commission of rebellion.

ATTACHMENT *out of the forest*, is one of the three courts held in the forest. The lowest court is called the court of attachment, or wood-mote court; the mean, swan-mote; and the highest, the justice in eyre's seat.

This attachment is by three means, by goods and chattles, by body, pledges, and mainprize, or the body only. This court is held every forty days throughout the year, whence it is called forty-days court.

ATTACHMENT *of privilege*, is by virtue of a man's privilege to call another to that court whereto he himself belongs, and in respect whereof he is privileged to answer some action.

ATTACHMENT, *foreign*, is an attachment of money or goods, found within a liberty or city, to satisfy some creditor within such liberty or city.

By the custom of London and several other places, a man can attach money or goods in the hands of a stranger to satisfy himself.

ATTAINDER, in law, is when a man has committed felony or treason, and sentence is passed upon him for the same. The children of a person attainted of treason, are, thereby, rendered incapable of being heirs to him, or to any other ancestor; and if he were noble before, his posterity are degraded and made base: nor can this corruption of blood be salved but by an act of parliament, unless the sentence be reversed by a writ of error.

ATTAINDER, *bill of*, a bill brought into parliament for attainting, condemning, and executing a person for high-treason.

ATTAINT, in law, a writ which lies against a jury that have given a false verdict in any court of record, in a real or personal action, where the debt or damages amount to above forty shillings.

If the verdict be found false the judgment by common law was, that the jurors meadows should be ploughed up, their houses broken down, their woods grubbed up, all their lands and tenements forfeited, &c. but by statute the severity of the common law is mitigated, where a petty jury is attainted, and there is a pecuniary penalty appointed.

But if the verdict be affirmed, such plaintiff shall be imprisoned and fined.

ATTELABUS, in natural history, a genus of insects of the order Coleoptera. Head attenuated behind; antennæ thickening towards the lip.

Of the genus Attelabus, one of the principal species is the Attelabus coryli of Linnæus, which is a smallish insect, found chiefly on hazel trees, and is black with red wing-sheaths; and a variety sometimes occurs in which the thorax is red also; it usually measures about a quarter of an inch in length. A much smaller species is the Attelabus betulæ, which is found on the birch; it is entirely of a black colour, and is remarkable for gnawing the leaves of that tree during the early part of spring, in such a manner that they appear notched on the edges. The thighs of the hind-legs in this insect are of a remarkable thickened form. The larvæ of the attelabi do not seem to have been distinctly described, but they probably bear a resemblance to those of the genus Curculio. Linnæus refers to the genus attelabus some insects which by later entomologists have been otherwise arranged: among these is the elegant species called Attelabus apiarius, so named from the mischief which its larva occasionally commits among bee-hives, destroying the young of those insects. It is about three quarters of an inch in length, and of a beautiful violet-black, with red wing-shells, marked by three black transverse bands. The whole insect is also covered with fine short black hair. It is common in some parts of France, Germany, &c. Its larva above mentioned is of a bright red colour. There are 13 species.

ATTENDANT, in law, one that owes duty or service to another, or in some manner depends upon him, as a widow endowed of lands by a guardian, shall be attendant upon him.

ATTESTATION, in military affairs, is a certificate made by some justice of the peace, within four days after the enlistment of a recruit. This certificate is to bear testimony that the said recruit has been brought

before him in conformity to the mutiny act, and has declared his assent or dissent to such enlistment; and if duly enlisted, that the proper oaths have been administered, and that the 2nd and 6th sections of the articles of war against desertion have been read to him.

ATTITUDE, in painting and sculpture, the gesture of a figure, or statue; or it is such a disposition of their parts, as serves to express the action and sentiments of the person represented.

ATTORNEY *general*, is a great officer under the king, created by letters patent, whose office it is to exhibit informations, and prosecute for the crown in criminal causes, and to file the bills in the exchequer, for any thing concerning the king in inheritance or profits. To him come warrants for making of grants, pardons, &c.

ATTORNIES *at law*, are such persons as take upon them the business of other men, by whom they are retained. By the 2 Geo. II. cap. 23, s. 5, no person shall be permitted to act as an attorney, or to sue out any process in the name of any other person, in any courts of law, unless such person shall have been bound by contract in writing, to serve as a clerk for five years to an attorney, duly sworn and admitted in some of the said courts; and such person, during the said term of five years, shall have continued in such service, and unless such person, after the expiration of the said five years, shall be examined, sworn, admitted, and inrolled. And for every piece of vellum, parchment, or paper, upon which shall be written any such contract, whereby any person shall become bound to serve as a clerk aforesaid, in order to his admission as a solicitor or attorney, in any of the courts at Westminster, there shall be charged a stamp duty of 100*l.* 34 Geo. III. c. 14. And in order to his admission as a solicitor or attorney in any of the great courts of sessions in Wales, or in the counties palatine of Chester, Lancaster, or Durham, or in any court of record in England, holding pleas to the amount of 40 shillings, and not in any of the said courts of Westminster, there shall be charged a stamp duty of 50*l.* Every attorney, solicitor, notary, proctor, agent, or procurator, practising in any of the courts at Westminster, ecclesiastical, admiralty, or Cinque-port courts, in his Majesty's courts in Scotland, the great sessions in Wales, the courts in the counties Palatine, or any other courts holding pleas to the amount of 40 shillings, or more; shall take out a certificate annually, upon which there shall be charged, if the solicitor, &c. residing within the bills of mortality, a stamp-duty of 5*l.* in any other part of Great Britain 3*l.* Persons practising after the 1st day of November, 1797, without obtaining a certificate, shall forfeit 50*l.* and be incapable of suing for any fees. An attorney shall not be elected into any office against his will, such as constable, overseer of the poor, or churchwarden, or any office within a borough; but his privilege will not exempt him from serving in the militia, or finding a substitute. Black. Rep. 1123.

ATTRACTION, a general term, used to denote the power or principle by which bodies mutually tend towards each other, without regarding the cause or action that may be the means of producing the effect.

The philosopher Anaxagoras, who lived about 500 years before the Christian æra, is generally considered as the first who noticed this principle, as subsisting between the heavenly bodies and the earth, which he considered as the centre of their motions. The doctrines of Epicurus and of Democritus are founded on the same opinion.

Nicholas Copernicus appears to have been one of the first among the moderns, who had just notions of this doctrine.

After him, Kepler brought it still nearer perfection; having determined that bodies tended to the centres of the larger round bodies, of which they formed a part, and the smaller celestial bodies to the great ones nearest to them, instead of to the centre of the universe: he also accounted for the general motion of the tides on the same principle, by the attraction of the moon; and expressly calls it *virtus tractoria quæ in luna est;* besides this, he refuted the old doctrine of the schools, "that some bodies were naturally light, and for that reason ascended, while others were by their nature heavy and so fell to the ground;" declaring that no bodies whatsoever are absolutely light, but only relatively so, and that all matter is subjected to the law of gravitation.

Dr. Gilbert, a physician at London, was the first in this country who adopted the doctrine of attraction; in the year 1600, he published a work entitled, "De Magnete Magneticisque Corporibus; which contains a number of curious things; but he did not sufficiently distinguish between attraction and magnetism.

The next after him was Lord Bacon, who, though not a convert to the Coperni-

can system, yet acknowledged an attractive power in matter.

In France also, we find Fermat and Roberval, mathematicians of great eminence, maintaining the same opinion. The latter, in particular, made it the fundamental principle of his system of physical astronomy, which he published in 1644, under the title of "Arist. Samii de Mundi Systema."

Dr. Hooke, however, was the person who conceived the most just and clear notions of the doctrine of gravitation, of any before Newton; in his work called "An Attempt to prove the Motion of the Earth:" 1674. He observes that the hypothesis on which he explains the system of the world, is in many respects different from all others; and that it is founded on the following principles: 1. That all the heavenly bodies have not only an attraction or gravitation towards their own centres, but that they mutually attract each other within the sphere of their activity. 2. That all bodies which have a simple or direct motion, continue to move in a right line, if some force operating without incessantly does not constrain them to describe a circle, an ellipse, or some other more complicated curve. 3. That attraction is so much the more powerful, as the attracting bodies are nearer to each other.

But the precise determination of the laws and limits of the doctrine of attraction, was reserved for the genius of Newton: in the year 1666, he first began to turn his attention to this subject, when, to avoid the plague, he had retired from London into the country; but, on account of the incorrectness of the measures of the terrestrial meridian, made before this period, he was unable to bring his calculations on the subject to perfection at first.

Some years afterwards his attention was again called to attraction by a letter of Dr. Hooke's; and Picard, having about this time measured a degree of the earth, in France, with great exactness, he employed this measure in his calculations, instead of the one he had before used, and found, by that means, that the moon is retained in her orbit by the sole power of gravity, supposed to be reciprocally proportional to the squares of the distances.

According to this law, he also found, that the line described by bodies in their descent is an ellipse, of which the centre of the earth occupies one of the foci; and considering afterwards, that the orbits of the planets are in like manner ellipses, having the centre of the sun in one of their foci, he had the satisfaction to perceive, that the solution which he had undertaken only from curiosity, was applicable to some of the most sublime objects in nature. These discoveries gave birth to his celebrated work, which has justly immortalized his name, entitled "Philosophicæ Naturalis Principia Mathematica."

In generalising these researches, he shewed that a projectile may describe any conic section whatsoever, by virtue of a force directed towards its focus, and acting in proportion to the reciprocal squares of the distances. He also developed the various properties of motion in these kinds of curves, and determined the necessary conditions, so that the section should be a circle, an ellipse, or an hyperbola, which depend only upon the velocity and primitive position of the body, assigning in each case the conic section which the body would describe.

He also applied these researches to the motion of the satellites and comets, shewing that the former move round their primaries, and the latter round the sun, according to the same law; and he pointed out the means of determining by observation the elements of these ellipses.

He also discovered the gravitation of the satellites towards the sun, as well as towards the planets; and that the sun gravitates towards the planets and satellites, as well as that these gravitate towards each other: and afterwards extending, by analogy, this property to all bodies, he established the principle, that every molecule of matter attracts every body in proportion to its mass, and reciprocally as the square of the distance from the body attracted.

Having ascertained this principle, he from it determined, that the attractive force of a body on a point placed without it is the same as if the whole mass were united at the centre. He also proved that the rotation of the earth upon its axis must occasion a flattening of it about the poles; which has since been verified by actual measurement: and determined the law of the variation of the degrees in different latitudes, upon the supposition that the matter of the earth was homogeneous.

But, with the exception of what concerns the elliptical motions of the planets and comets, and the attractions of the heavenly bodies, these discoveries were not wholly completed by Newton. His theory of the figures of the planets is limited by the supposition of their homogeneity; and his solution of the problem of the precession of the

equinoxes is defective in several respects. He has perfectly established the principle which he had discovered; but left the complete development of its consequences to the geometers that should succeed him.

The profound analysis also, of which he was the inventor, had not been sufficiently perfected, to enable him to give complete solutions to all the difficult problems which arise, in considering the theory of the system of the world; so that he was oftentimes obliged to give only imperfect sketches or approximations, and leave them to be verified by a more rigorous calculation.

Attraction may be divided, with respect to the law it observes, into two kinds. 1. That which extends to sensible distances, such is the attraction of gravity, of which we have been treating, which is found in all bodies, and the attraction of magnetism and of electricity found in some particular bodies; 2. That which extends to very small, or insensible distances.

The attractions belonging to the first class must be as numerous as there are bodies situated at sensible distances. It has been proved that their intensity varies with the mass and the distance of the attracting bodies; it increases with the mass of those bodies, but diminishes as the distance between them increases. The rate of variation has been demonstrated to be inversely as the square of the distance in all cases of attraction belonging to the first class.

The nature of the attraction of gravity has been already discussed. It is, as far as the experience of man can extend, universal in all matter. The attractions of magnetism and of electricity are partial, being confined to certain sets of bodies, while the rest of matter is destitute of them; for it is well known that all bodies are not electric, and that scarcely any bodies are magnetic, except iron, cobalt, nickel, and chromium; and there is good reason to suspect that the magnetism of the three latter substances is caused by their containing some iron united to them.

The intensity of these three attractions increases as the mass of the attracting bodies, and diminishes as the square of the distance.

The first extends to the greatest distance at which bodies are known to be separated from each other. How far electricity extends has not been ascertained; but magnetism extends at least so far as the semidiameter of the earth. All bodies possess gravity; but it has been supposed that the other two attractions are confined to two or three subtile fluids, which constitute a part of all those bodies that exhibit the attractions of magnetism or of electricity.

If we compare the different bodies acted on by gravitation, we shall find that the absolute force of their gravitation is in all casès the same, provided their distances from each other, and their mass be the same; but this is by no means the case with electrical and magnetic bodies: in them the forces by which they are attracted towards each other, called electricity and magnetism, are exceedingly various, even when the mass and the distance are the same. Sometimes these forces disappear almost entirely; at other times they are exceedingly intense.

Gravity, therefore, is a force inherent in bodies; electricity and magnetism not so; a circumstance which renders the opinion of their depending on peculiar fluids extremely probable. If we compare the absolute force of these three powers with each other, it would appear that the intensity of the two last, every thing else being equal, is greater than that of the first; but their relative intensity cannot be compared, and is therefore unknown. Hence it follows that these different attractions, though they follow the same laws of variation, are not the same in kind.

The attractions between bodies at insensible distances, have been distinguished by the name of affinity, while the term attraction has been more commonly confined to cases of sensible distance.

Affinity may be considered as operating on homogeneous or heterogeneous substances. Homogeneous affinity urges substances of the same nature together as iron to iron, soda to soda. Heterogeneous affinity draws substances of different nature into union, as acid and alkalis.

Homegeneous affinity is usually denominated cohesion, and sometimes adhesion when the surfaces of bodies are only referred to; it is nearly universal; as far as is known, caloric and light alone are destitute of it.

Heterogeneous affinity is the cause of the formation of compound substances; thus muriatic acid unites with soda, and forms sea-salt; and sea-salt in saturated solution is united into masses by homogeneous affinity. Heterogeneous affinity is universal as far as is known; that is to say, there is no substance which is not attracted by some other substance. It is generally taken for grant-

ed, that every substance has more or less affinity for all others, though it is certainly assuming more than even analogy can warrant, and is a point which we have no means of ascertaining.

Affinity, like sensible attraction, varies with the mass and the distance of the attracting bodies. That cohesion varies with the mass cannot indeed be ascertained, because we have no means of varying the mass without at the same time altering the distance. But in cases of the adhesion of the surfaces of homogeneous bodies, which is undoubtedly an instance of homogeneous affinity, it has been demonstrated that the force of adhesion increases with the surface, which in some respect is the same as with the mass.

That heterogeneous affinity increases with the mass has been observed long ago in particular instances, and has been lately demonstrated by Berthollet to take place in every case. Thus a given portion of water is retained more obstinately by a large quantity of sulphuric acid, than by a small quantity. Oxygen is more easily abstracted from oxides which are oxydised to a maximum, than from those which are oxyded to a minimum. Lime only takes off the greatest part of the carbonic acid from potash, which still retains a portion of it; and sulphuric acid does not totally displace phosphoric acid from the lime united to it in phosphate of lime, a part of it remains undisturbed. In these and many other cases, a small portion of one substance is retained by a given quantity of another more strongly than a large portion; and Berthollet has shewn, that in all cases a large quantity of one substance is capable of abstracting a portion of another from a small portion of a third, how weak soever the affinity between the first and second is, and how strong soever that between the second and third.

That the force of affinity increases as the distance diminishes, and the contrary, is obvious; for it becomes insensible, whenever the distance is sensible, and, on the other hand, it becomes exceedingly great, when the distance is exceedingly diminished. But the particular rate which this variation follows is still unknown; some have supposed the rate to be the same as that of sensible attraction, and that its intensity varies inversely, as the square of the distance; no sufficient argument has ever been advanced, to prove this law to be incompatible with the phenomena of affinity; but, on the other hand, no proof has ever appeared in support of this opinion.

Affinity agrees with sensible attraction in every determinable point: like sensible attraction, it increases with the mass, and diminishes as the distance augments; consequently it is just to conclude, that attraction, whether it be sensible or insensible, is in all cases, the same kind of force, and regulated precisely by the same general laws.

The forces of affinity, though the same in kind, and possessing the same rate of variation with regard to distances, and also in respect to the mass, are vastly more numerous than those of sensible attraction; for, instead of three, they amount to as many as there are heterogeneous bodies. But even when the distance and the mass are the same, as far as can be judged, the affinity of two bodies for a third is not the same. Thus barytes has a stronger affinity for sulphuric acid than potash has; for, on equal portions of them being mixed with a small quantity of the acid, the barytes seizes a much larger proportion of the acid than the potash does. The difference of intensity extends to all substances, for there are scarcely any two bodies whose particles have precisely the same affinity for a third, and scarcely any two bodies whose component parts adhere together with exactly the same force.

Because these affinities do not vary in common circumstances, like magnetism and electricity, but are always the same when other circumstances are equal, it has been argued that they do not, like them, depend on peculiar fluids, the quantity of which may vary; but that they are permanent forces, inherent in every part of the attracting bodies.

But after the extraordinary discoveries that have been lately made of the powerful effects which electricity, as excited by the galvanic apparatus, has in chemical attractions: and when the great force of the affinity of the bases of potash and of soda to oxygen have been overcome by it, we must hesitate at least in continuing the above opinion; if we do not totally reject it, to adopt its reverse, and consider electric fire in future as the great agent of elective affinities. There is no reason why electric fire may not be subject to the same laws of attraction as other substances, and why it may not remain united to bodies in a latent or inactive state, as well as caloric; we have already shewn, that the mass of any substance has a powerful effect on its degree

of affinity; many of the effects of electric fire on affinity might be explained by this increased power of it when acting in a mass, or at farthest by supposing, that its power increased with its mass in a greater ratio than that of other substances.

It has been judiciously remarked, by a respectable chemical writer, that the variation of intensity, which forms so remarkable a distinction between affinity and gravitation, may be only apparent, and not real, and may only arise from the much nearer approach which the parts of one substance may be capable of, to those of a second, than to those of a third; and that thus it may be that barytes attracts sulphuric acid with greater intensity than potash, because the particles of barytes, when they act upon the acid, are at a smaller distance from it than the particles of the potash; to which we shall add, that it is possible that the degree of insensible distance to which the parts of substances can approach, depends on the quantity of latent electric fire combined with them, or in other words, on the degree of their relative attractions to electric fire.

This conjecture of the agency of electric fire, in elective attractions, has, at least, the advantage of the atomic theory, which has been advanced to account for the same phenomena, that it relates to matters which we know really exist, and which are not beyond the bounds of hope, indeterminable by experiment. With all due deference to the respectable characters who have used the atomic theory as an universal explainer, we beg leave to remind its admirers, that it is totally inconsistent with the laws of sound philosophy, to assume a fact as the basis of argument, which itself has never had the shadow of proof to support it, and which in its nature is incapable of experiment. It is idle, in the present respectable state of science, to talk any more of atoms: as well may we again revive the dreams of the ancients, about the materia subtilis; or those of Des Cartes, relative to vortices, as to reason of the shape, form, nature, and properties of atoms, which, from their very definition, are merely visionary, and which, the moment we conceive them as having shape, lose their essential quality of indivisibility; if the existence of atoms cannot be disproved, that is no argument in favour of their existence, in the way usually supposed; and the atomic theory has only this property in common with every other which lies beyond the reach of our senses.

Judicial astrology, magic, and many other chimeras, cannot be disproved; but, at least since the great law of truth has been adopted for philosophy, that no argument was to be admitted in it that was not demonstrable by experiment, or by proof equally satisfactory, mankind has ceased to be led astray by them.

It is now high time either to banish the atomic theory into the same regions of oblivion as the others above mentioned, or to prove the existence of the atoms on which it is founded; but as this is in its nature an impossibility, it is to be hoped that the time is not far distant, when philosophers will cease to confound imaginary beings with real existences, and when all that has been written of atoms, will be in no more esteem than the voluminous treatises de Pygmeis et Salamandris, which are to be found among the folios of some of our great academical libraries.

It is true, that the atomic theory accounts plausibly for many things we otherwise must be content to own are as yet beyond our knowledge; this may be a convenience to those who wish to impose on the ignorant; but all true lovers of science will despise so paltry a resource, especially when so much is now known, that we need no longer blush to own those points which are still involved in obscurity, and shew the boundaries on the map of science between the regions of knowledge and the terra incognita of visionary theory.

In the above respect of accounting for matters unknown, the ideal system of Bishop Berkley is equally powerful as, if not superior to, the atomic theory, and has the advantage over it, of turning our thoughts incessantly to the Almighty Author of all things; for which reason, if we must have recourse to improved theories, Berkley's very much deserve the preference.

As to the more minute nature of bodies, we know that all mineral substances are resolvable into small laminæ or spicula, of determinate shapes, which by their multifarious combinations produce the variously formed chrystals, which all mineral bodies may be resolved into by art, which most may be made to exhibit by skilful dissection, and which so many shew naturally. Vegetable substances are resolvable into small fibres, as are likewise animal substances for the most part: and from the laws of sound philosophy, we must consider the laminæ or spicula, which form the basis of crystallization, as the primary parts of

mineral bodies, and fibres as those of organized bodies, until something further can be proved on the subject. These primary parts of bodies adhere together, it is most probable, by the attraction of cohesion, (as do also their combinations into crystals and other forms), modified in some degree by that attraction caused by electric fire.

The attraction which takes place among substances in solution is not so easily comprehended; as we know nothing as yet of the exact state in which a substance, capable of solidity, exists, when dissolved in a fluid. In our present state of knowledge, we can only consider it as a fluid itself, capable of reassuming a solid form in certain circumstances.

The attraction which takes place between bodies in a state of vapour, is similar to that in a fluid state; their precise and minute state in that condition is unknown; but the combinations which ensue from the attractions of many in both states, are familiar to all chemists, and from them have proceeded many of the most useful substances which we possess. It is very fortunate for us, however, that if the knowledge of the minute and primary state of bodies is, as it were, concealed from our view by an impenetrable veil, it is not of any very great importance to us; as the effects which bodies produce on each other can be known to us without it, and it is this latter species of knowledge that affords us the dominion over nature, supplies our wants, and forms the basis of worldly happiness.

The characteristic marks of affinity may be reduced to the three following:

1. It acts only at insensible distances, and of course affects only the minute parts of bodies.

2. This force is always the same in the same substances; but is different in different substances.

3. This difference is considerably modified by the mass. Thus, though A has a greater affinity for C than B has, if the mass of B be considerably increased, while that of A remains unchanged, B becomes capable of taking a part of C from A.

ATTRIBUTES, in logic, are the predicates of any subject, or what may be affirmed or denied of any thing.

ATTRIBUTES, in painting and sculpture, are symbols added to several figures, to intimate their particular office and character.

Thus the eagle is an attribute of Jupiter; a peacock, of Juno; a caduce, of Mercury; a club, of Hercules; and a palm, of Victory.

ATTRITION, the rubbing or striking of bodies one against another, so as to throw off some of their superficial particles.

The grinding or polishing of bodies is performed by attrition, the effects of which are heat, light, fire, and electricity.

ATTRITION is also often used for the friction of such simple bodies as do not wear from rubbing against one another, but whose fluids are, by that motion, subjected to some particular determination; as the various sensations of hunger, pain, and pleasure, are said to be occasioned by the attrition of the organs formed for such impressions.

AVALANCHES, a name given in Swisserland and Savoy to those prodigious masses of snow which are precipitated, with a noise like thunder, and in large torrents, from the mountains, and which destroy every thing in their course, and have sometimes overwhelmed even whole villages. In 1719 an avalanche from a neighbouring glacier overspread the greater part of the houses and baths at Leuk, and destroyed a considerable number of inhabitants. The best preservative against their effects being the forests, with which the Alps abound; there is scarcely a village situated at the foot of a mountain that is not sheltered by trees; which the inhabitants preserve with uncommon reverence. Thus, what constitutes one of the principal beauties of the country, affords also security to the people.

AVAST, in the sea language a term requiring to stop, to hold, or to stay.

AUBLETIA, in botany, so named from M. Aublet, the author of the history of plants in Guiana, a genus of the Polyandria Monogynia class and order. Essential character, calyx five-leaved; corolla five-petalled; capsule many celled, echinate, with many seeds in each cell. There are four species natives of Guiana.

AUCTIONS, and AUCTIONEERS, every person exercising the trade of an auctioneer, within the bills of mortality, shall pay 20*s*. for a license; and without the bills of mortality 5*s*. Auctions and auctioneers are regulated by several statutes during the present reign. A bidder at an auction, under the usual conditions that the highest bidder shall be the purchaser, may retract his bidding any time before the hammer is down.

AUCUBA, a genus of the Monoecia Tetrandria. Essential character, male flow-

toothed; corolla four-petalled; berry one-seeded; female nectary none; nut one-celled. One species, a large tree of Japan.

AUDIENCE, is the name of a court of justice established in the West Indies by the Spaniards, answering in effect to the parliaments of France.

These courts take in several provinces, called also audiences, from the names of the tribunal to which they belong.

AUDIENCE is also the name of an ecclesiastical court, held by the archbishop of Canterbury, wherein differences upon elections, consecrations, institutions, marriages, &c. are heard.

AUDITORY *nerves*, in anatomy, a pair of nerves arising from the medulla oblongata, with two trunks, the one of which is called the *portio dura*, hard portion; the other *portio mollis*, or soft portion. See ANATOMY.

AVENA, in botany, *oat-grass*; class Triandria Digynia; natural order, Gramina. Generic character: calyx, glume generally many-flowered, two-valved, loosely collecting the flowers; valves lanceolate, acute, ventricose, loose, large, awnless; corolla two-valved; lower valve harder than the calyx; the size of the calyx roundish, ventricose, acuminate at both ends, emitting from the back an awn, spirally twisted, reflex; nectary two-leaved; leaflets lanceolate, gibbous at the base; stamina filaments three, capillary; anthers oblong, forked; pistil. germ obtuse: styles two, reflex, hairy; stigma simple; pericarp none; corolla most firmly closed, grows to the seed and does not gape; seed one, slender, oblong, acuminate at both ends, marked with a longitudinal furrow. There are many species, of which we notice A. sativa, cultivated oat. Of this there are four varieties, the white, black, brown, or red, and the blue oat; panicled; calyxes two-seeded; seeds very smooth, one-awned; annual; culm or straw upwards of two feet high; panicle various in different varieties, but always loose and pendulous; the two glumes or chaffs of the calxy are marked with lines, pointed at the end, longer than the flower, and unequal; there are usually two flowers, and seeds in each calyx; they are alternate, conical, the smaller one is awnless, the larger puts forth a strong, two-coloured, bent awn, from the middle of the back. No botanist has been able to ascertain satisfactorily the native place of growth of this, or indeed of any other sort of grain now commonly cultivated in Europe. The varieties mentioned above have been long known, and others have been introduced, as the Poland, the Friesland or Dutch, and the Siberian or Tartarian oat. The blue oat is probably what is called Scotch greys. The white sort is most common about London, and those countries where the inhabitants live much upon oat-cakes, as it makes the whitest meal. The black is more cultivated in the northern parts of England, as it is esteemed a hearty food for horses. The red oat is much cultivated in Derbyshire, Staffordshire, and Cheshire; it is a very hardy sort, and gives a good increase. The straw is of a brownish red colour, very heavy, and esteemed better food for horses than either of the former sorts. In Lincolnshire they cultivate the sort called the Scotch greys. The Poland oat has a short plump grain, but the thickness of the skin seems to have brought it into disrepute among farmers. Add to this the straw is very short. It was sown by Mr. Lisle in 1709. Friesland or Dutch oat affords more straw, and is thinner skinned, and the grains mostly double. A white oat, called the potatoe oat in Cumberland, where it was lately discovered, promises, from the size of the grain and the length of the straw, to be the most valuable we possess; it is now very generally bought for sowing. The oat is a very profitable grain, and a great improvement to many estates in the North of England, Scotland, and Wales; for it will thrive in cold barren soils, which will produce no other sort of grain; it will also thrive on the hottest land; in short, there is no soil too rich or too poor, too hot or too cold for it; and in wet harvests, when other grain is spoiled, this will receive little or no damage. The meal of this grain makes a tolerably good bread, and is the common food of the country people in the north. It is also esteemed for pottage and other messes, and in some places they make beer with it. The best time for sowing oats is in February or March, according as the season is early or late. The black and red oats may be sown a month earlier than the white, because they are hardier. The advantage of early sowing is proved by experiment. White oats sown the last week in May have produced seven quarters the acre; and in Hertfordshire they do not sow them till after they have done sowing barley, which is found to be a good practice; this oat being more tender than the others. Mr. Marshall mentions the blowing of the sallow as a

direction for the sowing of this grain. He says, "most people allow four bushels of oats to an acre, but I am convinced that three bushels are more than enough; the usual produce is about 25 bushels to an acre, though I have sometimes known more than 30." But 40 bushels and more are certainly no unusual crop.

AVERAGE, in commerce, signifies the accidents and misfortunes which happen to ships and their cargoes, from the time of their loading and sailing to their return and unloading; and is divided into three kinds: 1. The simple or particular average which consists in the extraordinary expenses incurred for the ship alone, or for the merchandizes alone. Such is the loss of anchors, masts, and rigging, occasioned by the common accidents at sea; the damages which happened to merchandize by storm, prize, shipwreck, wet, or rotting; all which must be borne and paid by the thing which suffered the damage. 2. The large and common average being those expenses incurred, and damages sustained for the common good and security both of the merchandizes and vessels, consequently to be borne by the ship and cargo, and to be regulated upon the whole. Of this number are the goods or money given for the ransom of the ship and cargo, things thrown over-board for the safety of the ship, the expenses of unlading for entering into a river or harbour, and the provisions and hire of the sailors when the ship is put under an embargo. 3. The small averages which are the expenses for towing and pilotting the ship out, off, or into harbours, creeks, or rivers, one third of which must be charged to the ship, and two-thirds to the cargo.

Average is more particularly used for a certain contribution that merchants make proportionably towards their losses. It also signifies a small duty which those merchants who send goods in another man's ship pay to the master for his care of them, over and above the freight. Hence it is expressed in the bills of lading, paying so much freight for the said goods with primage and average accustomed.

AVERRHOA, in botany, a genus of the Decandria Pentagynia class of plants, whose flower consists of five lanceolated petals, the fruit is an apple of a turbinated and obtuse pentagonal figure, containing five cells, wherein are disposed angular seeds, separated by membranes. There are two species, trees, natives only of India, and other warm parts of Asia: singular for the fruit growing frequently on the trunk itself, below the leaves. The flower resembles that of the geranium; but the fruit is totally different: it is a poma, five-celled, and containing many seeds. The A. bilimbi is described as a beautiful tree, with green flesh fruit, filled with a grateful acid juice: the substance and seeds not unlike those of a cucumber: it grows from top to bottom, at all the knots and branches. A syrup is made of the juice, and a conserve of the flowers.

AVES, *birds*, the name of the second class of animals, according to the Linnæan system. They have been described as animals having a body covered with feathers and down; jaws protracted and naked: two wings, formed for flight, and two feet. They are aereal, vocal, swift, and light, and destitute of external ears, lips, teeth, scrotum, womb, bladder, epiglottis, corpus callosum and its arch, and diaphragm. The feathers are disposed over each other in the form of a quincunx, intermixed with down, distinct from the quill and tail feathers, convex above, concave beneath, narrower on the outside, lax at the fore-end, hollow and horny at the base, with a central pith, and furnished on each side the elongated shaft with parallel, approximate, distinct, and flat laminæ, composing the vane; they vary in colour according to age, sex, season, or climate, except the quill and tail feathers, which are more constant and chiefly characteristic. The eggs are various in number, size, and colour, but always covered with calcareous shell, deposited in an artificial nest, and hatched by the genial warmth of the parent. The body is oval, terminated by a heart-shaped rump, and furnished all over with aereal receptacles communicating with the lungs or throat, necessary for flight or song, and which may be filled or emptied at pleasure; the rump has two glands, secreting an unctuous fluid, which is pressed out by the bill to anoint the discomposed parts of the feathers; the bill is horny, extending from the head, either hooked at the end for tearing the prey, or slender for searching in the mire, or flat and broad for gobbling; and is used for building nests, feeding the young, climbing, or as an instrument of offence and defence; eyes lateral, furnished with orbits, and nictitant membrane; ears truncate without auricles; wings compressed, consisting of moveable joints, and covered with quills and feathers; legs placed usually near the centre of gravity, with toes and claws of various shapes; tail serving as the rudder or director of the

body, they are mostly monogamous, or live in single pairs, and migrate into milder climates, upon defect of food or warmth, and a few become torpid in winter. The generic characters are taken from the bill, tongue, nostrils, ceræ, caruncles, and other naked parts. See Plate I. Aves.

Fig. 1. *a.* Spurious or bastard wings; *b.* lesser coverts of the wings, which are small feathers that lie in several rows on the bones of the wings; *c.* greater wing coverts or feathers that lie immediately over the quill feathers; *d.* scapulars, which take their rise from the shoulders, and cover the sides of the back; *e.* primary quill-feathers, that rise from the first bone; *f.* secondary quill-feathers, or those that rise from the second bone; *g.* tertials, which likewise take their rise from the second bone, forming a continuation of the secondaries, and seem to do the same with the scapulars that lie over them; these feathers are so long in some of the scolopax and tringa genera, that when the bird is flying, they give it the appearance of having four wings; *h.* rump; *i.* tail-coverts; *k.* tail-feathers; *l.* shoulders; *m.* crown; *n.* front; *o.* hind-head; *p.* nape; *q.* chin; *r.* throat; *s.* scrag or neck above; *t.* interscapular region; *u.* vent.

Fig. 2. *a.* Upper mandible; *b.* lower mandible; *c.* a tooth-like process; *d.* frontlet; *e.* front; *f.* crown; *g.* hind-head; *h.* nape; *i.* lores; *k.* temples; *l.* cheeks; *m.* chin; *n.* bristles at the base of the bill.

Fig. 3. *a.* A bill with the upper mandible hooked at the point, and furnished with a tooth-like process; *b.* the cere or naked skin which covers the base of the bill, and in which are placed the nostrils; *c.* orbits, or skin, which surrounds the eye: it is generally bare, but particularly in the parrot and heron.

Fig. 4. A flat bill pectinate at the edges, and furnished at the tip with a claw or nail.

Fig. 5. A foot formed for perching, having three toes before and one behind.

Fig. 6. A walking foot, having a spur on the heel.

Fig. 7. A climbing foot, having two toes before and two behind.

Fig. 8. A palmate or webbed foot.

Fig. 9. A semi-palmate or half-webbed foot.

Fig. 10. A pinnate or finned foot.

Fig. 11. A lobate foot.

There are six orders of birds, each of which contains several genera that will be noticed in their proper places. The orders are

1. Accipitres or rapacious kind.
2. Picæ or pye kind.
3. Anseres or duck kind.
4. Grallæ or crane kind.
5. Gallinæ or poultry kind.
6. Passeres or sparrow kind.

We may observe with regard to this class of animals, the admirable contrivances throughout the whole of their structure, for promoting their boyancy in air, for enabling them to move with celerity, and for directing their course. Their covering is of the lightest kind; yet the down with which they are supplied under their feathers is the warmest that could be devised; for in consequence of the air entangled as it were in its interstices, it is one of the slowest conductors of heat. The outer feathers, by their slanting disposition, and their natural oiliness, form a complete shelter to the body from wet; and the hollow structure of the wing feathers, by increasing their bulk without increasing their weight, renders them more buoyant in the air.

The whole form of the body is adapted to its flying with ease and celerity; the small head and sharp bill for diminishing the resistance of the air; the greater muscular strength, as well as an expansion of the wings, for impelling its body forward with celerity; and the broad feathers of the tail, moveable in almost every direction, for steering its course like the rudder of a ship.

The disposition of the lungs along the back-bone, and their communications with the cells in the bones of the wings, thighs, and breast, by admitting air in almost every part of the body, increases the buoyancy of the whole, and enables the bird to exist longer without breathing, which must be in a great measure impeded, if not suspended, during some of its rapid flights.

It has been observed, that the brilliancy of the plumage in the feathered tribe is only to be looked for in the warmer regions of Asia and Africa; but whoever has seen the beautiful king-fisher dart along the shaded brook, cannot allow that our own country has nothing to boast in the brilliancy of its birds. The crimson crown and variety of colours of the great woodpecker, the beautiful bars of black, blue, and white on the greater wing-coverts of the jay, and the elegant plumage of the pheasant, as well as the extreme beauty of the roller, and the Bohemian chatterer,

AVES.

Scott sc.

Explanation of terms used in Ornithology.

See the article AVES.

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which sometimes visit us from countries still farther north, prove that nature has not confined her works of elegance to regions within the tropics.

The whole class of birds differs essentially from all other animals in internal structure, as well as in external form and appearance; and every point of difference, when accurately examined, is evidently adapted to their peculiar habits. These will be noticed under the several orders and genera. To give but a single instance in this place: the accipitres have sight so piercing, that frequently, when so high as to be out of human ken, they can descry their prey upon the ground, and their flight is so rapid, that they can dart upon it with the celerity of a meteor. Their prey varies according to their strength and rapacity, from the lamb or kid, which the vulture bears away in his talons, to the smaller birds and mice, on which the hawk and owl tribes feast. To prevent the depredation that these would otherwise commit, nature has ordained that this tribe of birds should be the least prolific; few of them lay more than two eggs.

AUGEA, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted; corolla o; nectary ten-toothed; capsule ten-celled. One species, a native of the Cape.

AUGITE, a mineral of the Chrysolite family, found in basalt, sometimes in grains, but most commonly in crystals, mostly small and complete. Colour blackish green, sometimes passing into leek green, and rarely to liver brown. Specific gravity 3.22 to 3.47. Before the blow-pipe it is with difficulty converted into a black enamel: the constituent parts are

Silica	52.00
Lime	13.20
Alumina	3.33
Magnesia	10.00
Oxide of iron	14.66
——— manganese	2.00
	95.19
Loss	4.81
	100.00

It is found very abundantly in Bohemia, Transylvania, Hungary, Scotland, as at Arthur's Seat, near Edinburgh, and remarkably fine in the island of Ruma, one of the Hebrides, and equally beautiful at Arendal, in Norway. Augite is distinguished from olivino by its darker colours, different crystallization, greater hardness, and specific gravity. It used to be considered as a product of fire; but the circumstance of its occurring wrapped up, not imbedded in lava, demonstrates that it is one of the constituent parts of the mother-stone, which has escaped fusion.

AUGMENT, in grammar, an accident of certain tenses of Greek verbs, being either the prefixing of a syllable, or an increase of the quantity of the initial vowels.

Of these there are two kinds, the *augmentum temporale*, or of a letter, when a short vowel is changed into a long one, or a diphthong into another longer one; and *augmentum syllabicum*, or of a syllable, when a syllable is added at the beginning of the word.

AUGMENTATION, was the name of a court erected 27 Hen. VIII. so called from the augmentation of the revenues of the crown, by the suppression of religious houses, and the office still remains, wherein there are many curious records, though the court has been dissolved long since.

Augmentation, in heraldry, are additional charges to a coat-armour, frequently given as particular marks of honour, and generally borne either on the escutcheon or a canton; as have all the baronets of England, who have borne the arms of the province of Ulster in Ireland.

Augmentation, in music, a term confined to the language of fuguists, and is the doubling the value of the notes of the subject of a fugue or canon: or, the giving the intervals of the subject in notes of twice the original length.

AUGRE, or Awgre, an instrument used by carpenters and joiners to bore large round holes, and consisting of a wooden handle and an iron blade, terminated at bottom with a steel bit.

AVIARY, a place set apart for feeding and propagating birds. It should be so large, as to give the birds some freedom of flight; and turfed, to avoid the appearance of foulness on the floor. See Apis and Bees.

AVICENA, Ebu Sina, in biography, has been accounted the prince of Arabian philosophers and physicians. He was born at Assena, near Bokhara, in 978; and died at Hamadan in 1036, being 58 years of age.

The first years of Avicena were employed in the study of the Belles Lettres, and the Koran, and at ten years of age he was perfect master of the hidden senses of that

book. Then applying to the study of logic, philosophy, and mathematics, he quickly made a rapid progress. After studying under a master the first principles of logic, and the first five or six propositions of Euclid's elements, he became disgusted with the slow manner of the schools, applied himself alone, and soon accomplished all the rest by the help of the commentators only.

Possessed with an extreme avidity to be acquainted with all the sciences, he studied medicine also. Persuaded that this art consists as much in practice as in theory, he sought all opportunities of seeing the sick; and afterwards confessed that he had learned more from such experience than from all the books he had read. Being now in his sixteenth year, and already celebrated for being the light of his age, he determined to resume his studies of philosophy, which medicine, &c. had made him for some time neglect: and he spent a year and a half in this painful labour, without ever sleeping all this time a whole night together. At the age of 21, he conceived the bold design of incorporating in one work all the objects of human knowledge; and he carried it into execution in an Encyclopedia of 20 volumes, to which he gave the title of the "Utility of Utilities."

Many wonderful stories are related of his skill in medicine, and the cures which he performed. Several princes had been taken dangerously ill, and Avicena was the only one that could know their ailments, and cure them. His reputation increased daily, and all the princes of the East desired to retain him in their families, and in fact he passed through several of them. But the irregularities of his conduct sometimes lost him their favour, and threw him into great distresses. His excesses in pleasures, and his infirmities, made a poet say, who wrote his epitaph, that the profound study of philosophy had not taught him good morals, nor that of medicine the art of preserving his own health.

After his death, however, he enjoyed so great a reputation, that till the 12th century he was preferred for the study of philosophy and medicine to all his predecessors. Even in Europe his works, which were very numerous, were the only writings in vogue in the schools.

AVICENNIA, in botany, so named in honour of a celebrated oriental physician, who flourished in the eleventh century at Ispahan, a genus of the Didynamia Angiospermia class and order. Essential character: calyx five-parted; corolla two-lipped, the upper lip square; capsule coriaceous, rhomboid, one-seeded. There are three species, natives of the East and West Indies. A. tomentosa, a tree, agrees mostly with the mangrove, rising about 15 feet; its trunk is not so large, having a smooth, whitish green bark, and from the stem are twigs propagating the tree like that: the branches at top are jointed towards their ends where the leaves come out opposite, on very small petioles, two inches and a half long, and about an inch broad: the flowers are many at the top of the branches, white and tetrapetalous. It is found on the north and south sides of Jamaica, growing in low moist ground. A. nitida grows forty feet high, a native of Martinico: the creeping roots throw up abundance of suckers. A. resinifera produces a green coloured gum, so much esteemed by the natives of New Zealand, and which is very hot in the mouth.

AVIGNON *berry*, taken from the rhamnus infectorius, and used in France by dyers for making a yellow colour. They are gathered unripe, bruised, and boiled in water, mixed with the ashes of vine stalks to give a body, and then strained through linen. The colour is chiefly used for silk, but it will not well bear the heat of the sun. The plant grows, as its name imports, in the neighbourhood of Avignon.

AULA *regis*, was a court established by William the Conqueror in his own hall. It was composed of the king's great officers of state resident in his palace, who usually attended on his person, and followed him in all his progresses and expeditions; which being found inconvenient and burthensome, it was enacted by the great charter, c. 11, that common pleas shall no longer follow the king's court, but shall be holden in some certain place, which certain place was established in Westminster Hall, where the aula regis originally sat when the king resided in that city, and there it has ever since continued. 3 Black. 37.

AULIC, an epithet given to certain officers of the empire, who compose a court, which decides, without appeal, in all processes entered in it. Thus we say, aulic council, aulic chamber, aulic counsellor, The aulic council is composed of a president. who is a Catholic; of a vice-chancellor, presented by the archbishop of Mentz; and of eighteen counsellors, nine of whom are Protestants, and nine Catholics. They are divided into a bench of lawyers, and always follow the emperor's court, for which reason they are called *justitium imperatoris*, the em-

peror's justice, and aulic council. The aulic court ceases at the death of the emperor, whereas the imperial chamber of Spire is perpetual, representing not only the deceased emperor, but the whole Germanic body, which is reputed never to die.

AVOIRDUPOIS, or AVERDUPOIS *weight*, a sort of weight used in England, the pound whereof is made up of sixteen ounces.

This is the weight for the larger and coarser commodities, such as groceries, cheese, wool, lead, &c. Bakers who live not in corporation-towns, are to make their bread by avoirdupois weight, those in corporations, by troy weight. Apothecaries buy by avoirdupois weight, but sell by troy. The avoirdupois ounce is less than the troy ounce, in the proportion of 700 to 768; but the avoirdupois pound is greater than the troy pound in the proportion of 700 to 576, or as 17 to 14 nearly: for

1 *lb.* avoirdupois = 7000 *grains* troy.
1 *lb.* troy .... = 5760 .... do.
1 *oz.* avoirdupois = 437½......... do.
1 *oz.* troy .... = 480 .... do.

AVOWEE, one who has a right to present to a benefice. See ADVOWSON.

AURELIA, in natural history, a term formerly employed by naturalists to express that intermediate state in which all lepidopterous, and most other insects, remain for some time, between the caterpillar form and the period in which they are furnished with wings, with antennæ, and other organs appertaining to the perfect insect. Aurelia and crysalis are synonymous words, both alluding to the golden splendour of the case in which the creature, during that state, is contained. This brilliant appearance seems to be confined to the Papilio tribe, so that the terms aurelia and chrysalis are altogether inapplicable, in a general manner, to insects in that state. These terms are now discarded in favour of the more expressive one *pupa*, which Linnæus has adopted in their stead; a term which implies that the insect, like an infant, remains in its swaddling clothes.

AURICLE, in anatomy, that part of the ear which is prominent from the head, called by many authors *auris externa*.

AURICLES *of the heart*. These are a kind of appendages of the heart at its base, and are distinguished by the names of the right and left. The right auricle is much larger than the left, and this is placed in the hinder, that in the anterior part. They are intended as diverticula for the blood, during the systole. Their substance is muscular, being composed of strong fibres, and their motion is not synchronous but achronous with that of the heart. See ANATOMY.

AURICULAR *medicines*, such as are used in the cure of distempers in the ear.

AURIGA, the *Waggoner*, in astronomy, a constellation of the northern hemisphere, consisting of 23 stars, according to Tycho, 40 according to Hevelius, and 66 in the Britannic Catalogue. This constellation is represented by the figure of an old man, in a posture somewhat like sitting, with a goat and her kids in his left hand, and a bridle in his right.

AURORA *borealis*, or AURORA *septentrionalis*, in physiology, the northern dawn or light, sometimes called streamers, is an extraordinary meteor, or luminous appearance, shewing itself in the night-time in the northern part of the heavens: and most usually in frosty weather. It is usually of a reddish colour, inclining to yellow, and sends out frequent corruscations of pale light, which seem to rise from the horizon in a pyramidal undulating form, and shoot with great velocity up to the zenith. The aurora borealis appears frequently in form of an arch, chiefly in the spring and autumn, after a dry year. The arch is partly bright, partly dark, but generally transparent; and the matter of which it consists is also found to have no effect on the rays of light which pass through it. Dr. Hamilton observes, that he could lainly discern the smallest speck in the Pleiades through the density of those clouds which formed the aurora borealis in 1763, without the least diminution of its splendour, or increase of twinkling.

This kind of meteor, which is more uncommon as we approach towards the equator, is almost constant during the long winter, and appears with the greatest lustre in the polar regions. In the Shetland isles, the "merry dancers," as the northern lights are there called, are the constant attendants of clear evenings, and afford great relief amidst the gloom of the long winter nights. They commonly appear at twilight, near the horizon, of a dun colour, approaching to yellow; they sometimes continue in that state for several hours, without any perceptible motion; and afterwards they break out into streams of stronger light, spreading into columns, and altering slowly into 10,000 different shapes, and varying

their colours from all the tints of yellow to the most obscure russet. They often cover the whole hemisphere, and then exhibit the most brilliant appearance. Their motions at this time are most amazingly quick; and they astonish the spectator with the rapid change of their form. They break out in places where none were seen before, skimming briskly along the heavens, are suddenly extinguished, and are succeeded by an uniform dusky tract. This again is brilliantly illuminated in the same manner, and as suddenly left a dark space. In some nights, they assume the appearance of large columns, on one side of the deepest yellow, and on the other, gradually changing till it becomes undistinguished from the sky. They have generally a strong tremulous motion from one end to the other, and this continues till the whole vanishes. As for us, who see only the extremities of these northern phenomena, we can have but a faint idea of their splendour, and motions. According to the state of the atmosphere, they differ in colour; and sometimes assuming the colour of blood, they make a dreadful appearance. The rustic sages who observe them, become prophetic, and terrify the spectators with alarms of war, pestilence, and famine: nor, indeed, were these superstitious presages peculiar to the northern islands: appearances of a similar nature are of ancient date; and they were distinguished by the appellations of "phasmata," "trabes," and "bolides," according to their forms and colours. In old times they were either more rare, or less frequently noticed: but when they occurred, they were supposed to portend great events, and the timid imagination formed of them aerial conflicts.

In the northern latitudes of Sweden and Lapland, the auroræ borealis are not only singularly beautiful in their appearance, but afford travellers, by their almost constant effulgence, a very beautiful light during the whole night. In Hudson's bay, the aurora borealis diffuses a variegated splendour, which is said to equal that of the full moon. In the north-eastern parts of Siberia, according to the description of Gmelin, these northern lights are observed to "begin with single bright pillars, rising in the north, and almost at the same time in the north-east, which gradually increasing, comprehend a large space of the heavens, rush about from place to place with incredible velocity, and finally, almost cover the whole sky up to the zenith, and produce an appearance as if a vast tent was expanded in the heavens, glittering with gold, rubies, and sapphire. A more beautiful spectacle cannot be painted; but whoever should see such a northern light for the first time, could not behold it without terrour. For however fine the illumination may be, it is attended, as I have learned from the relation of many persons, with such a hissing, cracking, and rushing noise through the air, as if the largest fire-works were playing off. To describe what they then hear, they make use of the expression 'spolochi chodjat,' that is, 'the raging host is passing.' The hunters, who pursue the white and blue foxes in the confines of the Icy sea, are often overtaken in their course by these northern lights. Their dogs are then so much frightened, that they will not move, but lie obstinately on the ground, till the noise has passed. Commonly, clear and calm weather follows this kind of northern lights. I have heard this account, not from one person only, but confirmed by the uniform testimony of many, who have spent part of several years in these very northern regions, and inhabited different countries from the Yenisei to the Lena; so that no doubt of its truth can remain. This seems indeed to be the real birth place of the aurora borealis."

This account of the noises attending the aurora borealis, allowing for some degree of exaggeration, has been corroborated by other testimonies. A person, who resided seven years at Hudson's Bay, confirms M. Gmelin's relation of the fine appearance and brilliant colours of the northern lights, and particularly of their rushing noise, which he affirms he has frequently heard, and compares it to the sound produced by whirling round a stick swiftly at the end of a string. A similar noise has also been heard in Sweden. Mr. Nairne also, being in Northampton at a time when the northern lights were remarkably bright, is confident he perceived a hissing, or whizzing sound. Mr. Belknap, of Dover, in New Hampshire, North America, testifies to this fact. M. Cavallo says, that the crackling noise is distinctly audible, and that he has heard it more than once. Similar lights, called auroræ australes, have been long since observed towards the south pole, and their existence has been more lately ascertained by Mr. Forster, who assures us that in his voyage round the world with Captain Cooke, he observed them in high southern latitudes, though attended with phenomena some-

what different from those which are seen here. On February 17, 1773, in south latitude 58°, "a beautiful phenomenon (he says) was observed during the preceding night, which appeared again this and several following nights. It consisted of long columns of a clear white light, shooting up from the horizon to the eastward, almost to the zenith, and gradually spreading on the whole southern part of the sky. These columns were sometimes bent sideways at their upper extremities; and though in most respects similar to the northern lights (aurora borealis) of our hemisphere, yet differed from them in being always of a whitish colour, whereas ours assume various tints, especially those of a fiery and purple hue. The sky was generally clear when they appeared, and the air sharp and cold, the thermometer standing at the freezing point."

The periods of the appearance of these northern lights are very inconstant. In some years they occur very frequently, and in others they are more rare; and it has been observed that they are more common about the time of the equinoxes than at other seasons of the year. Dr. Halley (see Philos. Trans. No. 347, p. 406,) has collected together several observations, which form a kind of history of this phenomenon. After having particularly described the various circumstances which attended that observed by himself and many others in March, 1716, and which was singularly brilliant, he proceeds with informing us, that the first account of similar phenomena recorded in the English annals, is that of the appearance which was noticed January 30, 1560, and called "burning spears," by the author of a book intitled "A Description of Meteors," by W. F. D. D. reprinted at London, in 1654. The next appearance of a like kind, recorded by Stow, occurred on October 7, 1564. In 1574, as Camden and Stow inform us, an aurora borealis was seen for two successive nights, *viz.* 14th and 15th of November, with appearances similar to those observed in 1716, and which are now commonly noticed. The same phenomenon was twice seen in Brabant, in 1575, *viz.* on the 13th of February and the 28th of September; and the circumstances attending it were described by Cornelius Gemma, who compares them to spears, fortified cities, and armies fighting in the air. In the year 1580, M. Mastline observed these phasmata, as he calls them, at Bakgang, in the county of Wirtemberg, in Germany, no less than seven times in the space of twelve months; and again at several different times, in 1581. On September 2nd, 1621, the same phenomenon was seen over all France; and it was particularly described by Gassendus, in his "Physics," who gave it the name of "aurora borealis." Another was seen all over Germany in November 1623, and was described by Kepler. Since that time, for more than eighty years, we have no account of any such phenomenon, either at home or abroad. In 1707, Mr. Neve observed one of small continuance in Ireland; and in the same year, a similar appearance was seen by Romer, at Copenhagen; and during an interval of eighteen months, in the years 1707 and 1708, this sort of light had been seen no less than five times. Hence it should seem, says Dr. Halley, that the air, or earth, or both, are not at all times disposed to produce this phenomenon, though it is possible it may happen in the day time, in bright moon shine, or in cloudy weather, and so pass unobserved. Dr. Halley further observes, that the aurora borealis of 1716, which he described, was visible from the west of Ireland to the confines of Russia, and to the east of Poland; extending at least near 30° of longitude, and from about the 50th degree of north latitude, over almost all the north of Europe; and in all places at the same time, it exhibited appearances similar to those which he observed at London. He regrets, however, that he was unable to determine its height for want of contemporary observations at different places.

Father Boscovich has determined the height of an aurora borealis, observed on the 16th of December 1737, by the Marquis of Poleni, to have been 825 miles; and Mr. Bergman, from a mean of thirty computations, makes the average height of the aurora borealis to be 72 Swedish, or (supposing a Swedish mile to be about 6½ English miles) 468 English miles. Euler supposes the height to be several thousands of miles; and Mairan also assigns to these phenomena a very elevated region, the far greater number of them being, according to him, about 200 leagues above the surface of the earth. Dr. Blagden, speaking of the height of some fiery meteors (Phil. Trans. vol. lxxiv. p. 227), says, that "the aurora borealis appears to occupy as high, if not a higher region, above the surface of the earth, as may be judged from the very distant countries to which it has been visi-

ble at the same time;" he adds, that "the great accumulation of electric matter seems to lie beyond the verge of our atmosphere, as estimated by the cessation of twilight." However the height of these meteors, none of which appear to have ascended so high as 100 miles, is trivial, compared with the elevations above ascribed to the aurora borealis. But as it is difficult to make such observations on this phenomenon, as are sufficient to afford a just estimate of its altitude, they must be subject to considerable variation, and to material error.

It is not improbable, that the highest regions of the aurora borealis are the same with those in which fire-balls move; more especially as Dr. Blagden informs us, that instances are recorded, in which the northern lights have been seen to join, and form luminous balls, darting about with great velocity, and even leaving a train behind like the common fire-balls. This ingenious author, however, conjecturing that distinct regions are allotted to the electrical phenomena of our atmosphere, assigns the appearance of fire-balls to that region which lies beyond the limits of our crepuscular atmosphere; and a greater elevation above the earth to that accumulation of electricity in a lighter and less condensed form, which produces the wonderfully diversified streams and coruscations of the aurora borealis.

AUSTRAL, something relating to the south: thus the six signs on the south side of the equinoctial are called austral signs.

AUTER *fois acquit*, in law, a plea made by a criminal that he has been already acquitted of the same crime, with which he is charged. There are likewise pleas of auter fois convict and attaint, that he has been before convicted of the same felony.

AUTHENTIC, something of acknowledged and received authority. In law it signifies something clothed in all its formalities, and attested by persons to whom credit has been regularly given. Thus, we say, authentic papers, authentic instruments. In music, authentic is a term applied to four of the church modes or tones, which rise a fourth above their dominants, which are always a fifth above their finals; in this distinguished from the plegal modes, which fall a fourth below their finals. Thus when an octave is divided arithmetically according to the numbers 2, 3, 4, that is, when the fifth is flat, and the fourth sharp, the mode or tone is called authentic, in contradistinction to the plegal tone, where the octave is divided harmonically by the numbers 3, 4, 6, which makes the fourth a flat, and the fifth a sharp.

AUTHORITY, in a general sense, signifies a right to command, and make one's self obeyed.

AUTHORITY, in law, signifies a power given by word, or writing, to a second person to act something, and may be by writ, warrant, commission, letter of attorney, &c. and sometimes by law. An authority given to another, to do what a person himself cannot do is void; and it must be for doing a thing that is lawful, otherwise it will be no good authority.

Authority is represented in painting, like a grave matron sitting in a chair of state, richly clothed in a garment embroidered with gold, holding in her right hand a sword, and in her left a sceptre. By her side is a double trophy of books and arms.

AUTOGRAPHUM, the very hand writing of a person, or the original manuscript of a treatise or discourse. Autographa, or original manuscripts of the New Testament, are the copies written by the apostles, or by amanuenses under their immediate inspection. St. Paul seems generally to have adopted the latter mode; but to prevent the circulation of spurious epistles, he wrote the concluding benediction with his own hand. The early loss of the autographa of the New Testament affords matter of surprise, when it is known that the original manuscripts of Luther, and other eminent men who lived at the time of the reformation are still subsisting.

AUTOMATUM, or AUTOMATON, an instrument, or rather machine; which, by means of springs, weights, &c. seems to move itself, as a watch, clock, &c. Such also were Archytus's flying dove, Regiomontanus's wooden-eagle, &c. See ANDROIDES.

AUTUMN, the third season of the year, when the harvest and fruits are gathered in. Hence, in the language of the Alchemists, it signifies the time when the philosophers' stone is brought to perfection.

Autumn is represented, in painting, by a man at perfect age, clothed like the vernal, and likewise girded with a starry girdle; holding in one hand a pair of scales equally poized, with a globe in each; in the other, a bunch of divers fruits and grapes. His age denotes the perfection of this season, and the balance, that sign of the zodiac which the sun enters when our autumn begins.

AUTUMNAL *signs*, in astronomy, are the signs Libra, Scorpio, and Sagittarius, through which the sun passes during the autumn.

AUXILIARY *verbs*, in grammar, are such as help to form or conjugate others; that is, are prefixed to them, to form or denote the moods or tenses thereof. As *to have* and *to be*, in the English; *estre et avoir* in the French; *ho et sono* in the Italian, &c. In the English language, the auxillary verb *am*, supplies the want of passive verbs.

AUXILIARY, in military affairs: by this term is understood foreign or subsidiary troops, which are furnished to a belligerent power in consequence of a treaty of alliance, or for pecuniary considerations. Of the latter description may be considered the Swiss soldiers, who formerly served in France, and the Hessians who were employed by Great Britain, during a patt of the American war, and on other occasions.

AUXILIUM *curiæ*, in law, a precept or order of court, to cite, or convene one party at the suit of another.

AUXILIUM *ad filium militem faciendum, vel filiam maritandam*, a precept or writ directed to the sheriff of every county where the king or other lords had any tenants, to levy of them reasonable aid, towards the knighting his eldest son, or the marriage of his eldest daughter.

AWAIT, in law, way-laying, or laying-in-wait to execute some mischief. It is enacted, that no charter of pardon shall be allowed before any justice, for the death of a man slain by await or malice prepence. 13 Rich. II.

AWARD, in law, the judgment of an arbitrator, or of one who is not appointed by the law a judge, but chosen by the parties themselves for terminating their difference. See ARBITRATOR.

AWL, or AUL, among shoemakers, an instrument wherewith holes are bored through the leather, to facilitate the stitching or sewing the same. The blade of the awl is usually a little flat and bended, and the point ground to an acute angle.

AWME, or AUME, a Dutch liquid measure, containing eight steckans, or twenty verges or verteels, equal to the tierce in England, or to one-sixth of a ton of France.

AWN. See ARISTA.

AWNING, in the sea-language, is the hanging a sail, tarpauling, or the like, over any part of the ship, to keep off the sun, rain, or wind. That part of the poop-deck which is continued forward beyond the bulk-head of the cabin, is also called the awning.

AXETONE. See NEPHRITE.

AXILLA, in anatomy, the arm-pit, or the cavity under the upper part of the arm.

AXILLA, in botany, the space comprehended betwixt the stems of plants and their leaves.

AXIOM, in philosophy, is such a plain, self-evident, and received notion, that it cannot be made more plain and evident by demonstration; because it is itself better known than any thing that can be brought to prove it: as, that nothing can act where it is not; that a thing cannot be, and not be, at the same time; that the whole is greater than a part thereof; and that from nothing, nothing can arise. By axioms, called also maxims, are understood all common notions of the mind, whose evidence is so clear and forcible, that a man cannot deny them, without renouncing common sense and natural reason.

The rule whereby to know an axiom, is this: whatever proposition expresses the immediate clear comparison of two ideas, without the help of a third, is an axiom. But if the truth does not appear from the immediate comparison of two ideas, it is no axiom.

These sort of propositions, under the name of axioms, have, on account of their being self-evident, passed not only for principles of science, but have been supposed innate, and thought to be the foundation of all our other knowledge; though, in truth, they are no more than identic propositions: for to say that all right angles are equal to each other, is no more than saying, that all right angles are right angles, such equality being implied in the very definition. All considerations of these maxims, therefore, can add nothing to the evidence or certainty of our knowledge of them: and how little they influence the rest of our knowledge, how far they are from being the foundation of it, as well as of the truths first known to the mind, Mr. Locke, and some others, have undeniably proved. According to Bacon, it is impossible that axioms raised by argumentation should be useful in discovering new works; because the subtilty of nature far exceeds the subtilty of arguments: but axioms, duly and methodically drawn from particulars, will again easily point our new particulars, and so render the sciences active.

The axioms in use being derived from slender experience, and a few obvious particulars, are generally applied in a corresponding manner. No wonder, therefore, they lead us to few particulars; and if any instance, unobserved before, happen to turn up, the axiom is preserved by some trifling distinction, where it ought rather to be corrected.

AXIOM is also an established principle in some art or science.

Thus it is an established axiom in physics, that nature does nothing in vain; so it is in geometry, that if to equal things you add equals, the sums will be equal. It is an axiom in optics, that the angle of incidence is equal to the angle of reflection, &c. In which sense too, the general laws of motion are called axioms: whence it may be observed, that these particular axioms are but deductions from certain hypotheses.

AXIS, in geometry, the straight line in a plane figure, about which it revolves, to produce or generate a solid: thus, if a semicircle be moved round its diameter at rest, it will generate a sphere, the axis of which is that diameter.

AXIS, in astronomy. 1. Axis of the world, an imaginary right line conceived to pass through the centre of the earth, from one pole to the other, about which the sphere of the world in the Ptolemaic system revolves in its diurnal rotation. 2. The axis of a planet, is that line drawn through the centre about which the planet revolves. The sun, together with all planets, except Mercury, Saturn, and Herschel, are known by observation to move about their respective axis. The axis of the earth, during its revolution round the sun, remains parallel to itself, and is inclined to the plane of the ecliptic, making with it an angle of $66\frac{1}{2}$ degrees. 3. The axis of the equator, horizon, ecliptic, zodiac, &c. are right lines drawn through the centers of those circles perpendicular to their planes.

AXIS, in conic sections, a right line dividing the section into two equal parts, and cutting all its ordinates at right angles. See CONIC SECTIONS.

AXIS, in mechanics. The axis of a ballançe is that line about which it moves, or rather turns about. Axis of oscillation is a right line parallel to the horizon, passing through the centre about which a pendulum vibrates.

AXIS *in peritrochio*, one of the five mechanical powers, consisting of a peritrochium or wheel concentric with the base of a cylinder, and moveable together with it about its axis. See MECHANICS.

AXIS, in optics, is that ray, among all others that are sent to the eye, which falls perpendicularly upon it, and which consequently passes through the centre of the eye.

AXIS of a glass or lens, is a right line joining the middle points of the two opposite surfaces of the glass.

AXIS of incidence, in dioptrics, is a right line perpendicular in the point of incidence, to the refracting superficies, drawn in the same medium that the ray of incidence comes from.

AXIS of refraction is a right line drawn through the refracting medium, from the point of refraction, perpendicular to the refracting superficies.

AXYRIS, in botany, a genus of the Monoecia Triandria class of plants, in the male flowers of which the calyx is a perianthium composed of four patent, obtuse leaves, divided into three segments: there is no corolla: in the female flowers the calyx is composed of five obtuse, concave, connivent, and permanent leaves, with the two exterior ones shorter than the rest; there is no corolla; nor is there any pericarpium; the seed is single, oblong, compressed obtuse, and contained in the cup.

AYE-*aye*, in natural history, a singular quadruped discovered by Sonnerat, in the island of Madagascar, and described in his voyage to the East Indies. Sonnini forms a new genus of this animal, under the name of "Chieromys," but Gmelin ranks it under the genus "Sciuras," which see.

AYENIA, in botany, so called in honour of the Duke d'Ayen, a great promoter of the science of botany, of the Gynandria Pentandria class and order. Natural order of Columniferæ. Malvaceæ Jussica. Essential character, monogynous. Calyx five-leaved. Petals united into a star, with long claws; five anthers, under the star; capsule five-celled. There are four species; of which, three are natives of South America, and one of Jamaica. These plants are propagated by seeds, sown in the spring in hotbeds, where they must continue; but they will want a good portion of free air. If exposed to the open atmosphere, they will not thrive; and if too much drawn, they do not flower well. The plant will live through the winter, but as they perfect their seeds the first year, the old plants are seldom continued.

AZALEA, in botany, of the Pentandria

Monogynia class and order. Natural order, Bicornes; Rhododendra, Jussieu. Essential character, corolla bell-shaped; stamina inserted into the receptacle; capsule five-celled. There are seven species. A. pontica much resembles the rhododendron ponticum, but it has five stamens and yellow corollas, not ten stamens and violet-coloured corollas as that has. The leaves are smaller, ovate, and ciliate: a native of Pontus. A. indica is a shrub three feet in height, with a trunk an inch thick, having a rough cinereous brown bark; the branches are short, twisted and irregular; leaves stiff villose, close and evergreen; beautiful bright red flowers cover the whole upper part of the shrub. Native of the East Indies; much cultivated in Japan for the elegance of its flowers, and the variety in their size and colours. A. viscosa is a low shrub rising with several slender stems nearly four feet high. The leaves come out in clusters at the ends of the shoots, without order: the flowers come forth in clusters between the leaves, and have the appearance of those of the honeysuckle, and are as agreeably scented. They appear in the middle of July, but do not bring forth seeds in England. The Pontic and Indian species have not yet been cultivated in Europe. The viscosa grows naturally in shade, and upon moist ground in most parts of North America, from whence many of the plants have been sent of late years to England, and several of them have produced their beautiful flowers. They must have a moist soil, and a shady situation, otherwise they will not thrive; they can only be propagated by shoots from their roots, and laying down their branches. The best time for laying down the young shoots is at Michaelmas, and if they are covered with some old tan to keep out the frost, it will be of great use to them.

AZIMUTH, in astronomy, an arch of the horizon, intercepted between the meridian of the place and the azimuth, or vertical circle passing through the centre of the object, which is equal to the angle of the zenith formed by the meridian and verticle circle: or it is found by this proportion. As the radius to the tangent of the latitude of the place, so is the tangent of the sun's or star's altitude, for instance, to the co-sine of the azimuth from the south, at the time of the equinox.

Azimuth, *magnetical*, an arch of the horizon, intercepted between the azimuth, or vertical circle passing through the centre of any heavenly body, and the magnetical meridian.

This is found by observing the object with an azimuth compass.

Azimuth *compass*, an instrument adapted to find, in a more accurate manner than by the common sea-compass, the sun or star's magnetical amplitude, or azimuth. It is also used to take the bearings of headlands, ships, and other objects at a distance. The azimuth compass differs from the common sea compass in this, that the circumference of the card, or box, is divided into degrees, and there is fitted to the box an index with two sights, which are upright pieces of brass placed diametrically opposite so each other, having a slit down the middle of them, through which the sun, or star, or other object is to be viewed, at the time of observation. See Compass.

Azimuth *dial*, one whose style or gnomon is at right angles to the plane of the horizon.

Azimuth *circles*, called azimuths, or vertical circles, are great circles of the sphere, intersecting each other in the zenith and nadir, and cutting the horizon at right angles in all the points thereof.

The horizon being divided into 360°, there are reckoned 360 azimuths.

These azimuths are represented by the rhumbs on common sea charts, and on the globe they are represented by the quadrant of altitude when screwed in the zenith. On these azimuths is reckoned the height of the stars, and of the sun when not in the meridian.

AZOTE, or *nitrogen*, in chemistry, a gas that forms the unrespirable part of the atmospheric air, and it exists in the proportion of about 78 per cent, by bulk, or 74 per cent in weight. The properties by which this gas was first distinguished, were principally negative, in direct opposition to those of oxygen, the other constituent of the atmosphere: the latter supporting combustion and animal life in an eminent degree, while the former was found to be immediately fatal to animals; hence its name azote, or the extinguisher of life. Oxygen also produces a great change in almost all metallic substances, which is known by the term oxydation; azote, on the contrary, not only extinguishes life and flame immediately, but produces no change whatever on combustible bodies immersed in it.

This gas is obtained by the following methods: if a quantity of iron filings and sul-

phur, mixed together with a little water, be put into a glass receiver full of atmospheric air, it will in a few days absorb all the oxygen, and the remainder will be azote, or more properly azotic gas. Phosphorus may be substituted for the iron filings and sulphur, and the absorption will be completed in 24 hours. Diluted nitric acid, poured on muscular flesh, and the heat of 100° applied, will furnish azotic gas. By whatever means obtained, its properties are always the same; *viz.* it is invisible and elastic: it has no smell; its specific gravity is about ,98, or, according to Mr. Davy, ,978; 100 cubic inches of it weighs upwards of 30 grains; it cannot be breathed by animals without instant suffocation; and it is not sensibly absorbed by water. Azote is a constituent part of all animal bodies: it is the cause of the production of ammonia; and in certain proportions with oxygen, it forms the nitric acid: according to the experiments of Mr. Davy, nitric acid is formed of

29.5 of azote
70.5 of oxygen.

The composition of nitric acid was discovered by Mr. Cavendish, and hence is explained how the putrefaction of animal matters is favourable to the production of nitre. It is from this combination that azote obtained the name of nitrogen, or the base of nitric acid: this, indeed, seems the preferable term, azote only implying the general property of destroying life, which is common to many of the other gases. Azote in its different stages of oxydation becomes nitrous oxide, nitrous gas, as well as nitric acid.

In experiments, azote is detected chiefly by its negative properties. Gas may be inferred to be azotic, if it instantly extinguishes a taper immersed in it, and at the same time is not sensibly absorbed by water or liquid alkali; nor renders lime water turbid; which does not blacken the solutions of lead or silver; which mixes with oxygen in any proportion, without diminution, or the production of red fumes, and when so mixed, does not explode by the contact of a lighted body.

AZURE, among painters, the beautiful blue colour, with a greenish cast, prepared from the lapis lazuli, generally called ultramarine. See COLOUR.

With greater propriety, however, azure signifies that bright blue colour prepared from the lapis armenus, a different stone from the lapis lazuli, though frequently confounded together. This colour is, by our painters, commonly called Lambert's blue.

AZURE, in heraldry, the blue colour in the arms of any person below the rank of a baron. In the escutcheon of a nobleman, it is called saphire; and in that of a sovereign prince, Jupiter. In engraving, this colour is expressed by lines, or strokes drawn horizontally. This colour may signify justice, perseverence, and vigilance; when compounded with

Or.	it signifies	Cheerfulness
Arg.		Vigilance
Gul.		Readiness
Ver.		Enterprise
Pur.		Goodness
Sab.		Mournfulness.

AZURITE. See LAZULITH.

B.

B, The second letter of the alphabet, and first consonant, is formed in the voice by a strong and quick expression of the breath, and opening of the lips; and is therefore one of the labials: as a mute, it hath a middle power between the smooth sound of P, and the rougher sound of F and V.

B is also used as an abbreviation: thus, in music, B stands for the tone above A, as B♭, or ♭B, does for B flat, or the semitone major above A: B also stands for bass, and B. C. for *basso continuo*, or thorough bass. As a numeral, B was used by the Greeks and Hebrews, to denote 2; but among the Romans, for 300, and with a dash over it (thus $\overline{B}$) for 3000.

BABOON, the name of that tribe of apes which have short tails. See SIMIA.

BABYLONICS, in literary history, a fragment of the ancient history of the world, ending at 267 years before Christ; and composed by Berosus or Berossus, a priest of Babylon, about the time of Alexander. Babylonics are sometimes also cited in ancient writers by the title of Chaldaics. The Babylonics were very consonant with Scripture, as Josephus, and the ancient christian

chronologers assure us; whence the author is usually supposed to have consulted the Jewish writings. Berosus speaks of an universal deluge, an ark, &c. He reckons 10 generations between the first man and the deluge, and marks the duration of the several generations by *saroi*, or periods of 223 lunar months; which, reduced to years, differ not much from the chronology of Moses.

The Babylonics consisted of three books, including the history of the ancient Babylonians, Medes, &c. but only a few imperfect extracts are now remaining of the work, preserved chiefly by Josephus and Syncellus; where all the passages of citations of ancient authors out of Berosus are collected with great exactness. Annius, of Viterbo, kindly offered his assistance to supply the loss, and forged a complete Berosus out of his own head. The world has not thanked him for the imposture.

BABYROUSSA, in zoology, the Indian hog. See Sus.

BACCHARIS, in botany, *ploughman's spikenard:* of the Syngenesia Polygamia Superflua class and order. Natural order compositæ; compound flowers, division the third discoideæ; corymbiferæ, Jussieu. Essential character; calyx imbricate, cylindric; florets, female mixed with hermaphrodites; down simple; receptacle naked. There are nine species; most of the plants are shrubby; the flowers are disposed commonly in corymbs.

BACHELOR, or BATCHELOR, a man who still continues in the state of celibacy, or who was never married, and who, in certain cases, is subject to a double tax.

BACHELOR was anciently a denomination given to those who had attained to knighthood, but had not a number of vassals sufficient to have their banner carried before them in the field of battle; or, if they were not of the order of bannerets, were not of age to display their own banner, but obliged to march to battle under another's banner. It was also a title given to young cavaliers, who having made their first campaign, received the military girdle accordingly. And it served to denominate him who had overcome another in a tournament, the first time he ever engaged.

BACHELORS, *knights*, were so called, as being the lowest order of knights, or inferior to bannerets.

BACHELORS, in an university sense, are persons that have attained to the bacca-laureat; or who have taken the first degree in the liberal arts and sciences. Before a person can be admitted to this degree at Oxford, it is necessary that he study there four years; three years more may entitle him to the degree of master of arts; and in seven years more he may commence bachelor of divinity. At Cambridge the degrees are usually taken much the same as at Oxford, excepting in law and physic, in either of which the bachelor's degree may be taken in six years. In France, the degree of bachelor of divinity is attained in five years study, that is, in two years of philosophy, and three of divinity.

BACHELOR, in music, one who has taken his first degree in music. A qualification formerly required of a candidate for this honour, was the being able to read and expound certain books in Boethius, a Greek writer in the science, of the sixth century. It is now required of the candidate, to compose an exercise for voices and instruments, in six parts, which exercise must be publicly performed in the music-school, or other place in the university.

BACILLARIA, in natural history, a genus of insects of the order Infusoria. Generic character: body consisting of cylindrical straw-like filaments, placed parallel to each other, and frequently changing their position. There is but a single species noticed by Gmelin, *viz.* B. paradoxa, found on the ulva latissima; body composed of linear, yellowish, short filaments, united together, forming themselves into a square zigzag, or extended line, but always preserving their parallelism and resting in a square.

BACK, in brewing, a large flat vessel in which the wort is put to stand and cool before boiling. The ingredients of beer pass through three kinds of vessels; they are mashed in one, worked in another, and cooled in a third, called backs or coolers.

BACK *gammon*, an ingenious game played with dice and tables, to be learned only by observation and practice.

However, the following rules concerning it cannot fail to be acceptable to our readers. In the first place, the men, which are thirty in number, being equally divided between the two gamesters, are placed thus, *viz.* two on the ace point, five on the side of your left hand table, three on the cinque, and five on the ace point of your right hand table, which are answered on the like points by your adversaries men: or they may be disposed thus, *viz.* two on the ace point, five on the double sice or sice-cinque point, three on the cinque point in your own tables, and

five on the sice point at home; which are to be answered by your adversary.

The men being thus disposed be sure to make good your trey and ace points; hit boldly, and come away as fast as you can.

When you come to a bearing have a care of making when you need not; and doublets now will stand you most in stead. If both bear together, he that is first off, without doublets, wins one; if both bear, and one goes off with doublets, he wins two. If your table be clear before your adversary's men are come in, that is back-gammon, which is three; but if you thus go off with doublets, it is four.

The great dexterity of this game is to be forward, if possible, upon safe terms; and so to point the men that it shall not be possible for the adversary to pass, though you have entered your men, till you give him liberty, after having got two to one of the advantage of the game.

Back *staff*, in the sea language, an instrument formerly used for taking the sun's altitude at sea: so called because the back of the observer is turned towards the sun during the observation.

Back *stays of a ship*, are ropes belonging to the main-mast and fore-mast, and the masts belonging to them; serving to keep them from pitching forwards or over-board.

BACKING, in law, a warrant of justice of peace, where a warrant granted in one jurisdiction is required to be executed in another; as where a felony has been committed in one county and the offender resides in another; in which case, on proof of the hand-writing of the justice who granted the warrant, a justice in such other county indorses, or writes his name at the back of it, thereby giving authority to execute the warrant in such other county.

BACON (Roger), in biography, an English monk of the Franciscan order, celebrated for his genius and learning, was born near Ilchester in Somersetshire, in the year 1214. He commenced his studies at Oxford; from whence he removed to the university of Paris, which at that time was esteemed the centre of literature: here he made such progress in the sciences, that he was esteemed the glory of the university, and was in high estimation with several of his countrymen, particularly with Robert Groothead, or Grouthead, afterwards Bishop of Lincoln, his great friend and patron. Having taken the degree of doctor, he took the habit of the Franciscan order, either while he was in France, or soon after his return to England, about the year 1240. He now pursued his favourite study of experimental philosophy with unremitting ardour and assiduity. In this pursuit, in experiments, instruments, and in scarce books, he informs us he spent, in the course of 20 years, no less than 2000*l*. which sum was generously furnished to him by some of the heads of the university, to enable him the better to pursue his noble researches. But such extraordinary talents, and progress in the sciences, which in that ignorant age were so little known to the rest of mankind, while they raised the admiration of the more intelligent, could not fail to excite the envy of his illiterate fraternity, whose malice he further drew upon him by the freedom with which he treated the clergy in his writings, in which he spared neither their ignorance nor their want of morals: these therefore found no difficulty in possessing the vulgar with the notion of Bacon's dealing with the devil. Under this pretence he was restrained from reading lectures; his writings were confined to his convent; and at length, in 1278, he himself was imprisoned in his cell, at 64 years of age. Being allowed, however, the use of his books, he still proceeded in the rational pursuit of knowledge, correcting his former labours, and writing several curious pieces.

When Bacon had been ten years in confinement, Jerom de Ascoli, general of his order, who had condemned his doctrine, was chosen pope by the name of Nicholas IV.; and being reputed a person of great abilities, and one who had turned his thoughts to philosophical studies, Bacon resolved to apply to him for his discharge; and to shew both the innocence and the usefulness of his studies, addressed to him a treatise "On the Means of avoiding the infirmities of Old Age." What effect this had on the pope does not appear; it did not at least produce an immediate discharge: however, towards the latter end of his reign, by the interposition of some noblemen, Bacon obtained his liberty; after which he spent the remainder of his life in the college of his order, where he died in the year 1294, at 80 years of age, and was buried in the Franciscan church. Such are the few particulars which the most diligent researches have been able to discover concerning the life of this very extraordinary man.

Bacon's printed works are: 1, "Epistola Fratris Rogeri Baconis de Secretis Operibus Artis et Naturæ, et de Nullitate Magiæ:" Paris, 1542, in 4to. Basil, 1593, in 8vo.

2. "Opus Majus:" London, 1733, in folio, published by Dr. Jebb. 3. "Thesaurus Chemicus:" Francf. 1603 and 1620. These printed works of Bacon contain a considerable number of essays; but there remain also in different libraries several manuscripts not yet published.

His other physical writings shew no less genius and force of mind. In his treatise "Of the Secret Works of Art and Nature," he shews that a person perfectly acquainted with the manner observed by nature in her operations would be able to rival her. In another piece, "Of the Nullity of Magic," he points out, with great sagacity and penetration, whence the notion of it sprung, and how weak all pretences to it are. From a perusal of his works, it is evident that Bacon was no stranger to many of the capital discoveries of the present and past ages. Gunpowder he certainly knew: thunder and lightning, he tells us, may be produced by art: for that sulphur, nitre, and charcoal, which when separate have no sensible effect, when mixed together in due proportion, and closely confined, and fired, yield a loud report. A more precise description of gunpowder cannot be given in words. He also mentions a sort of unextinguishable fire prepared by art: which proves that he was not unacquainted with phosphorus: and that he had a notion of the rarefaction of the air, and the structure of an air-pump, is past contradiction. He was the miracle, says Dr. Freind, of the age in which he lived, and the greatest genius, perhaps, for mechanical knowledge, that ever appeared in the world since Archimedes. He appears likewise to have been a master in the science of optics: he has accurately described the uses of reading-glasses, and shewn the way of making them. Dr. Freind adds, that he also describes the camera obscura, and all sorts of glasses which magnify or diminish any object, or bring it nearer to the eye, or remove it farther off. Bacon says himself, that he had great numbers of burning-glasses: and that there were none ever in use among the Latins, till his friend Peter de Mahara Curia applied himself to the making of them. That the telescope was not unknown to him, appears from a passage where he says, that he was able to form glasses in such a manner, with respect to our sight and the objects, that the rays shall be refracted and reflected wherever we please, so that we may see a thing under what angle we think proper, either near or at a distance, and be able to read the smallest letters at an incredible distance, and to count the dust and sand, on account of the greatness of the angle under which we see the objects: and also that we shall scarce see the greatest bodies near us, on account of the smallness of the angle under which we view them. His skill in astronomy was amazing: he discovered that error which occasioned the reformation of the calendar; one of the greatest efforts, according to Dr. Jebb, of human industry: and his plan for correcting it was followed by Pope Gregory the Thirteenth, with this variation, that Bacon would have had the correction to begin from the birth of our Saviour, whereas Gregory's amendment reaches no higher than the Nicene council.

On the whole, it cannot be doubted that Friar Bacon is justly entitled to everlasting remembrance, as a philosopher and truly great man. If knowledge, says Dr. Enfield, is now too far advanced for the world to derive much information from his writings, respect must nevertheless be paid to the memory of the man who knew more than his contemporaries, and who in a dark age added new lights to the lamp of science.

Bacon (Francis), in biography, Baron of Verulam, Viscount of St. Albans, and Lord High Chancellor of England under King James I. He was born in 1560, being son of Sir Nicholas Bacon, Lord Keeper of the Great Seal in the reign of Queen Elizabeth, by Ann daughter of Sir Anthony Cook, eminent for her skill in the Latin and Greek languages. He gave even in his infancy tokens of what he would one day become; and Queen Elizabeth had many times occasion to admire his wit and talents, and used to call him her young lord keeper. In his thirteenth year he was entered a student at Trinity College, Cambridge, where he studied the philosophy of Aristotle, and made such progress in his studies, that at sixteen years of age he had run through the whole circle of the liberal arts as they were then taught, and even began to perceive those imperfections in the existing philosophy, which he afterwards so effectually exposed, and thence not only overturned the tyranny which prevented the progress of true knowledge, but laid the foundation of that free and useful philosophy which has since opened a way to so many glorious discoveries. On his leaving the university, his father sent him to France; where, before he was 19 years of age, he wrote a general view of the state of Europe: but Sir Nicholas dying, he was obliged suddenly to return to England, where he applied himself to the

study of the common law, at Gray's-Inn. His merit at length raised him to the highest dignities in his profession, *viz.* of Attorney-general, and Lord High Chancellor. But being of an easy and liberal disposition, his servants took advantage of that temper, and their situation under him, by accepting presents in the line of his profession. Being abandoned by the king, he was tried by the house of lords for bribery and corruption, and by them sentenced to pay a fine of 40,000*l.* and to remain prisoner in the Tower during the king's pleasure. The king, however, soon after remitted the fine and imprisonment: but his misfortunes had given him a distaste for public affairs, and he afterwards mostly lived a retired life, closely pursuing his philosophical studies and amusements, in which time he composed the greatest part of his English and Latin works. Though even in the midst of his honours and employments he forgot not his philosophy, but in 1620 published his great work "Novum Organum." After some years spent in philosophical retirement, he was suddenly seized with pains in his head and stomach as he was travelling into the country. These obliged him to stop at Highgate, at the Earl of Arundel's, where he expired on the 9th of April, in the 66th year of his age. No memorial remains of his last hours, excepting a letter addressed to the nobleman in whose house he died, in which he compares himself to Pliny, who lost his life by approaching too near Vesuvius during an eruption. He was buried at St. Albans.

To Bacon unquestionably belonged a most commanding genius, capable of inventing, methodizing, and carrying forward to considerable maturity, a general plan for the improvement of natural science, by the only sure method of experiment. With a mind prompt in invention, patient in inquiry, and subtle in discrimination, neither affecting nor idolizing antiquity, he formed, and in a great measure executed, his great plan, "The Instauration of Sciences," in six parts. Of these the first is entitled "The Advancement of Learning:" the second is the "Novum Organum," or new method of employing the reasoning faculties in the pursuit of truth: the "Sylva Sylvarum," or History of Nature, is the third part; the fourth is entitled "Scala Intellectus;" a series of steps is pointed out, by which the understanding may regularly ascend in its philosophical inquiries: the fifth part is "Anticipationes Philosophicæ," intended as philosophical hints and suggestions: the sixth part, in which the universal principles of natural knowledge, drawn from experiments, should be exhibited in a regular and complete system, the author did not attempt to accomplish. The grand edifice, of which he laid the foundation only, he left to be finished by the united labours of philosophers of future ages. With confidence in the merit of his own works, and depending on posthumous celebrity, Bacon begins his last testament with "My name and memory I leave to foreign nations: and to mine own countrymen, after some time is passed over." Upon the superstructure that has been raised on the foundation of experimental philosophy he established will be read by distant ages "Bacon, the father of experimental philosophy."

Bacon, (John) in biography, a celebrated sculptor, descended from an ancient family in Somersetshire, was born in Southwark, Nov. 24, 1740, where his father, Thomas Bacon, a cloth-worker, resided. When very young, Mr. Bacon discovered a great inclination for drawing, common to children; but not being particularly encouraged in it he never made much proficiency in the art. At the age of 14 he was bound apprentice to Mr. Crispe of Bow Church Yard, where he was employed in painting on porcelain. He occasionally assisted in the manufactory of china at Lambeth, particularly in forming small ornamental pieces, which he executed with so much taste as to indicate no ordinary powers. To his honour be it mentioned, that by the encouragement he met with, he was able, principally, to support his aged parents, reduced in their circumstances, though by such an exertion he was obliged to abridge himself of the necessaries of life. At the manufactory at Lambeth he had an opportunity of observing models of different sculptors, which were sent to a pottery on the same premises to be burnt. From the sight of these he immediately conceived a strong inclination for his future profession. Having once made his choice he was unremitting in his diligence, and it is said that his progress was as rapid as his turn was sudden and unpremeditated. During this young man's apprenticeship he formed a design of making statues in artificial stone; and to his exertions is to be attributed the flourishing state of Coade's manufactory. In 1763, Mr. Bacon attempted to work in marble, and having never seen the operation performed he was led to invent an instrument for transferring the form of the model

to the marble, this is called "'getting out the points," which has been brought into use both in England and on the continent. The advantage of this instrument consists in its certainty and exactness, in its taking a correct measurement in every direction, in its occupying a small compass, and that it may be transferred either to the model or the marble, without a separate instrument for each. In 1768, Mr. Bacon removed to the West end of the town and attended upon the Royal Academy, where he received his first instructions, having never before seen the art of modelling or sculpture regularly performed. In the following year the gold medal for sculpture, the first ever given by the society, was voted to Mr. Bacon. He became an associate of that body in the year 1770, and from this time his reputation was firmly established, and he obtained patronage of the highest rank. It would be needless to attempt an enumeration of the various works by which he attained to the first eminence in a very difficult profession. The efforts of his genius are widely spread, and his name will long live the pride of the country which gave him birth, and from which he had never occasion to travel for the improvement of his talents, or the cultivation of a fine taste.

This distinguished artist was suddenly attacked with an inflammation in his bowels on the 4th of August, 1799, which terminated his life in little more than two days. He died August 7th, in the 59th year of his age; leaving behind him a character as great for integrity and virtue as he had obtained in his profession as a sculptor. He had been twice married, and left ten children and a widow to mourn the loss of a tender father and affectionate husband. Cecil's Memoirs of Bacon.

BACOPA, in botany, a genus of the Pentandria Monogynia class and order. Natural order Succulentæ: portulaceæ Jussieu. Essential character: corolla with a short tube spreading at top; stem inserted into the tube of the corolla; stigma headed; capsule one-celled. There is but one species, *viz.* the B. aquatica, which is a native of Cayenne, on the borders of rivulets, flowering and bearing fruit in December. The French call it *herbe-aux-brulures*, on account of its efficacy in curing burns.

BACTRIS, in botany, a genus of plants of the Monoecia Hexandria class and order. Natural order of Palms. Essential character: male, calyx threeparted; corolla one-petalled, three-cleft; stamina six. Female, calyx one-leaved, three-toothed; corolla one-petalled, three-toothed; stigma obscurely three-cleft; drupe coriaceous. There are two species, the minor and major, natives of Carthagenia in South America.

BADGE, in naval architecture, an ornament placed on the outside of small ships, very near the stern, containing either a window or the representation of one.

BÆCKIA, in botany, so named in honour of Abraham Baeck, the intimate friend of Linnæus, who received this plant from him; of the Octandria Monogynia class and order. Natural order Calycanthemæ; Onagreæ Jussieu. Essential character: calyx funnel-form, five-toothed; corolla five-petalled; capsule globular, four-celled, crowned. There is one species, *viz.* B. frutescens, a shrub which has the habit of southernwood, with wand-like branches, and opposite short simple twigs. It is a native of China, and called their tiongina.

BÆOBOTRYS, in botany, of the Pentandria Monogynia class and order. Essential character: corolla tubular, with a five-cleft border; calyx double; outer two-leaved; inner one-leafed, bell-shaped; berry globose, one-celled, growing to the calyx; many seeded. A single species, *viz.* the B. nemoralis, native of the Isle of Tanna in the South Seas.

BAGGAGE, in military affairs, denotes the clothes, tents, utensils of divers sorts, provisions, and other necessaries belonging to an army.

Before a march, the waggons with the baggage are marshalled according to the rank which the several regiments bear in the army; being sometimes ordered to follow the respective columns of the army, sometimes to follow the artillery, and sometimes to form a column by themselves. The general's baggage marches first; and each waggon has a flag, shewing the regiment to which it belongs.

BAGPIPE, a musical instrument of the wind kind, chiefly used in country places, especially in the north: it consists of two principal parts; the first a leathern bag, which blows up like a foot-ball by means of a port-vent or little tube fitted to it, and stopped by a valve: the other part consists of three pipes or flutes, the first called the great pipe or drone, and the second the little one, which pass the wind out only at the bottom; the third has a reed and is played on by compressing the bag under the arm, when full, and opening or stopping the

holes, which are eight, with the fingers. The little pipe is ordinarily a foot long; that played on thirteen inches; and the portvent six.

This instrument has been so long a favourite with the natives of Scotland, that it may be considered as a national instrument. It is not known when it was introduced there, but it has been conjectured that the Danes or Norwegians carried it into the Hebrides, where it has been known from times immemorial.

BAGS, *sand*, in military affairs, filled with earth or sand to repair breaches, and the embrasures of batteries when damaged by the enemies fire, or by the blast of the guns; they are also used to raise a parapet in haste, or to repair one that is beaten down. They are only used when the ground is rocky and does not afford earth enough to carry on the approaches.

BAHAR, or BARRE, in commerce, weights used in several places in the East Indies.

There are two of these weights, the one the great bahar with which they weigh pepper, cloves, nutmegs, ginger, &c. and contains five hundred and fifty pounds of Portugal, or about five hundred and twenty-four pounds nine ounces avoirdupois weight. With the little bahar they weigh quicksilver, vermilion, ivory, silk, &c. It contains, about four hundred and thirty-seven pounds nine ounces avoirdupois weight.

BAIL, in law, the setting at liberty one arrested or imprisoned, upon an action, either civil or criminal, upon sureties taken for his appearance at a day and place assigned; and is either common or special.

Common bail is in actions of small prejudice, or slight proof, in which case any sureties are taken. But if the plaintiff make affidavit that the cause of action amounts to 10*l.* or upwards, in order to arrest the defendant, and make him put in substantial sureties for his appearance, called special bail; it is then required that the true cause of action be expressed in the body of the writ.

Special bail, are two or more persons, who, after arrest, undertake generally, or enter into bond to the sheriff in a certain sum, to insure the defendant's appearance at the return of the writ: this obligation is called bail-bond.

In criminal cases all persons, by the common law, might be bailed till they were convicted of the offence laid to their charge: the statutes have made many exceptions to this rule: when these do not intervene bail may, upon offering sufficient surety, be taken either in court or, in particular cases, by the sheriff, coroner, or other magistrate, but usually by justices of peace, in the following cases, persons of good fame charged with the suspicion of man-slaughter or other inferior homicide. Persons charged with petit larceny, or any felony not before specified. Accessaries to felony, not being of evil fame, nor under strong presumption of guilt. Bail cannot be taken upon an accusation of treason, nor murder, nor in the case of man-slaughter if the person be clearly the slayer; nor does it extend to such as being committed for felony have broken prison, nor to persons out-lawed, nor to those who have abjured the realm, nor approvers, nor persons taken in the fact of felony, nor persons charged with house-burning, nor persons taken by writ of *excommunicato capiendo.*

BAILE, or BALE, in the sea language. The seamen call throwing the water by hand out of the ship or boat's hold bailing. They also call those hoops that bear up the tilt of a boat its bails.

BAILLY (JEAN SYLVAIN), a celebrated French astronomer, historiographer, and politician, was born at Paris the 15th of September, 1736, and has figured as one of the greatest men of the age, being a member of several academies, and an excellent scholar and writer. He enjoyed for several years the office of keeper of the king's pictures at Paris. He published, in 1766, a volume in 4to, "An Essay on the Theory of Jupiter's Satellites," preceded by a history of the astronomy of these satellites. In the "Journal Encyclopédique," for May and June 1773, he addressed a letter to M. Bernoulli, astronomer royal at Berlin, upon some discoveries relative to these satellites, which he had disputed. In 1768, he published the Eulogy of Leibnitz, which obtained the prize at the Academy of Berlin, where it was printed. In 1770, he printed at Paris, in 8vo. the Eulogies of Charles the Vth, of De la Caille, of Leibnitz, and of Corneille. This last had the second prize at the Academy of Rouen, and that of Moliere had the same honour at the French Academy.

M. Bailly was admitted into the Academy as adjunct, the 29th of January, 1763, and as associate, the 14th of July, 1770.—In 1775 came out at Paris, in 4to, his "History of the Ancient Astronomy," in one vo-

lume: in 1779, the "History of Modern Astronomy," in two volumes: and in 1787, the "History of the Indian and Oriental Astronomy," being the second volume of the Ancient Astronomy. Besides these, he was author of many memoirs in the several volumes of the Academy.

In the beginning of the revolution in France, in 1789, M. Bailly took an active part in that business, and was so popular and generally esteemed, that he was chosen the first president of the states general, and of the national assembly, and was afterwards for two years together the mayor of Paris; in both which offices he conducted himself with great spirit, and gave general satisfaction.

He soon afterward, however, experienced a sad reverse of fortune; being accused by the ruling party of favouring the king, he was arrested and summarily condemned, by an infamous and bloody tribunal, for incivism and wishing to overturn the republic, and died by the guillotine at Paris, on the 11th day of November, 1793, at 57 years of age. The character of this great man can only be estimated by his works. In his person he was tall; his deportment was grave and sedate, and he blended firmness with sensibility.

BAILIFF, an officer appointed for the administration of justice within a certain district, called a bailiwick. Hence the sheriff is considered a bailiff to the crown; and his court, of which he has the care, and in which he is to execute the king's writ, is called his bailiwick, so also his officers who execute writs, warrants, &c. are called bailiffs.

Bailiffs *of franchises*, those appointed by every lord within his liberty to do such offices therein as the bailiff errant does at large in the county.

There are also bailiffs of forests, and bailiffs of manors, who direct husbandry, fell trees, gather rents, pay quit rents, &c.

Bailiff, *water*, an officer appointed in all port-towns for the searching of ships, gathering the toll for anchorage, &c. and arresting persons for debts, &c. on the water.

Bailiff, however, is still applied to the chief magistrate of several corporate towns. The government of some of the king's castles is also committed to persons called bailiffs, as the bailiff of Dover castle.

BAILIWICK, that liberty which is exempted from the sheriff of the county, over which liberty the lord thereof appoints his own bailiff, with the like power within his precinct as an under-sheriff exercises under the sheriff of the county: or it signifies the precinct of a bailiff, or the place within which his jurisdiction is terminated: such is the bailiff of Westminster.

BAILMENT, is the delivery of things to another, sometimes to be delivered back to the bailer, sometimes to the bailee, and sometimes to a third person: this delivery is called a bailment. The following rules are binding in the law of bailments: a baillee who derives no advantage for his undertaking is responsible only for gross negligence. A bailer who alone receives benefit from the bailment is responsible for slight neglect. When the bailment is beneficial to both parties, the bailee must be answerable for ordinary neglect. No bailee shall be charged for a loss by inevitable accident, or irresistible force, except by special agreement. Robbery by force is considered as irresistible, but a loss by private stealth is presumptive evidence of ordinary neglect.

BAINBRIDGE (John), an eminent physician, astronomer, and mathematician. He was born in 1582, at Ashby de la Zouch, Leicestershire. He studied at Cambridge, where having taken his degrees of bachelor and master of arts, he returned to Leicestershire, kept a grammar-school, and at the same time practised physic; employing his leisure hours in studying mathematics, especially astronomy, which had been his favourite science from his earliest years. By the advice of his friends, he removed to London, to better his condition, and improve himself with the conversation of learned men there; and here he was admitted a fellow of the College of Physicians. His description of the comet, which appeared in 1618, greatly raised his character, and procured him the acquaintance of Sir Henry Savile, who, in 1619, appointed him his first professor of astronomy at Oxford. On his removal to this university, he entered a master commoner of Merton College; the master and fellows of which appointed him junior reader of Linacer's lecture in 1631, and superior reader in 1635. As he resolved to publish correct editions of the ancient astronomers, agreeably to the statutes of the founder of his professorship, that he might acquaint himself with the discoveries of the Arabian astronomers, he began the study of the Arabic language when he was above 40 years of age. Before he had com-

pleted that work he died, in the year 1643, at 61 years of age.

Dr. Bainbridge wrote many works, but most of them have never been published; those that were published, were the three following: *viz.* 1. "An Astronomical Description of the late Comet, from the 18th of November, 1618, to the 16th of December following;" 4to, London, 1619. 2. "Procli Sphæra, Ptolomæi de Hypothesibus Planetarum Liber singularis." To which he added Ptolomy's "Canon Regnorum." He collated these pieces with ancient manuscripts, and gave a Latin version of them, illustrated with figures; printed in 4to, 1620. 3. "Canicularia." A treatise concerning the Dog-star, and the canicular days: published at Oxford, in 1648, by Mr. Greaves, together with a demonstration of the heliacal rising of Sirius, the Dog-star, for the parallel of Lower Egypt. Dr. Bainbridge undertook this work at the request of Archbishop Usher, but he left it imperfect; being prevented by the breaking out of the civil war, or by death.

There were also several dissertations of his prepared for and committed to the press the year after his death, but the edition of them was never completed.

BAIT, in fishing, a thing prepared to take and bring fishes to. See ANGLING.

BAITING is applied to the act of smaller or weaker beasts attacking and harrassing greater and stronger ones. Bulls and bears are baited by mastiffs, or bull-dogs. The practice of bull-baiting, and other sports of the same kind, which cannot be too strongly reprobated, may be traced to an early period of our history. In the twelfth century, it was a common practice on every holiday. In the reign of Henry VIII. many herds of bears were maintained for the purpose of baiting. Queen Mary had a great exhibition of bear-baiting immediately after mass, with which to entertain her sister Elizabeth, then a prisoner in Hatfield-house; and the same princess, soon after her accession to the throne, entertained the foreign ambassadors with the baiting of bulls and bears. The custom of bull-baiting was most ingeniously defended by Mr. Windham in the House of Commons in the session of 1803, when a bill was brought in to stop that inhuman practice. Whales are baited by a kind of fish called oriæ or killers, ten or twelve of which will attack a young whale at once, and not leave him till he is killed.

BAKER (THOMAS), a mathematician of some eminence, was born at Ilton, in Somersetshire, in 1625. He entered upon his studies at Oxford, in 1640, where he remained seven years. He was afterwards appointed vicar of Bishop's-Nymmet, in Devonshire, where he lived a studious and retired life for many years, chiefly pursuing the mathematical sciences; of which he gave a proof of his critical knowledge, in the book he published, concerning the general construction of biquadratic equations, by a parabola and a circle; the title of which book at full length is, "The Geometrical Key; or the Gate of Equations unlocked: or a new Discovery of the Construction of all Equations, howsoever affected, not exceeding the fourth degree; *viz.* of Linears, Quadratics, Cubics, Biquadratics, and the finding of all their roots."

A little before his death, the Royal Society sent him some mathematical queries; to which he returned such satisfactory answers, as procured the present of a medal, with an inscription full of honour and respect. Mr. Baker died at Bishop's Nymmet, 1690, in the 65th year of his age.

BAKER (HENRY), an ingenious and diligent naturalist, was born in London about the beginning of the 18th century. He was brought up under an eminent bookseller, but being of a philosophical turn of mind, he quitted that line of business soon after the expiration of his apprenticeship, and took to the employment of teaching deaf and dumb persons to speak and write, &c. in which occupation, in the course of his life he acquired a handsome fortune. For his amusement he cultivated various natural and philosophical sciences, particularly botany, natural history, and microscopical subjects, in which he especially excelled, having, in the year 1744, obtained the Royal Society's gold medal, for his microscopical experiments on the crystallizations and configurations of saline particles. He published various papers in the Transaction of the Royal Society, of which he was a worthy member, as well as of the Society of Antiquaries.

He was author of many pieces on various subjects, the principal of which were, his Treatise on the Water Polype, and two Treatises on the Microscope; *viz.* "The Microscope made easy," and "Employment for the Microscope," which have gone through several editions.

Mr. Baker married Sophia, youngest daughter of the celebrated Daniel Defoe, by whom he had two sons, who both died before him. He terminated an honourable

and useful life, at his apartments in the Strand, on the 25th of November, 1774, being then upwards of 70 years of age.

BAKER, a person whose occupation or business is to prepare bread, or to reduce meal of any kind, whether simple or compound, into bread, biscuits, &c. It is not known when this very useful business first became a particular profession. Bakers were a distinct body of people in Rome, nearly two hundred years before the christian æra, and it is supposed that they came from Greece. To these were added a number of freemen, who were incorporated into a college, from which neither they nor their children were allowed to withdraw. They held their effects in common without enjoying any power of parting with them. Each bakehouse had a patron, who had the superintendency of it; and one of the patrons had the management of the others, and the care of the college. So respectable were the bakers at Rome, that occasionally one of the body was admitted among the senators. Even by our own statutes the bakers are declared not to be handicrafts; and in London they are under the particular jurisdiction of the lord-mayor and aldermen, who fix the price of bread, and have the power of fining those who do not conform to their rules. Bread is made of flour, mixed and kneaded with yeast, water, and a little salt. It is known in London under two names, the white or wheaten, and the household: these differ only in degrees of purity: and the loaves must be marked with a W or H, or the baker is liable to suffer a penalty. The process of bread-making is thus described: to a peck of meal are added a handful of salt, a pint of yeast, and three quarts of water, cold in summer, hot in winter, and temperate between the two. The whole being kneaded, will rise in about an hour; it is then moulded into loaves, and put into the oven to bake. The oven takes more than an hour to heat properly, and bread about three hours to bake. The price of bread is regulated according to the price of wheat; and bakers are directed in this by the magistrates, whose rules they are bound to follow. By these the peck-loaf of each sort of bread must weigh seventeen pounds six ounces avoirdupois weight, and smaller loaves in the same proportion. Every sack of flour is to weigh two hundred and a half; and from this there ought to be made, at an average, twenty such peck loaves, or eighty common quartern loaves. If the bread was short in its weight only one ounce in thirty-six, the baker formerly was liable to be put in the pillory; and for the same offence he may now be fined, at the will of the magistrates, in any sum not less than one shilling, nor more than five shillings for every ounce wanting; such bread being complained of and weighed in the presence of the magistrate within twenty-four hours after it is baked, because bread loses in weight by keeping. It is said that scarcely any nation lives without bread, or something as a substitute for it. The Laplanders have no corn, but they make bread of their dried fishes, and of the inner rind of the pine, which seems to be used not so much on account of the nourishment to be obtained from it, as for the sake of having a dry food. In Norway they make bread that will keep thirty or forty years, and the inhabitants esteem the old and stale bread in preference to that which is newly made. For their great feasts particular care is taken to have the oldest bread; so that at the christening of a child, for instance, they have usually bread which has been baked perhaps at the birth of the father, or even grandfather. It is made from barley and oats, and baked between two hollow stones. See BISCUIT.

BALÆNA, the whale, in zoology, a genus of the Mammalia class, belonging to the order of Cete. The characters of this genus are these: the balæna, in place of teeth, has a horny plate on the upper jaw, and a double fistula or pipe for throwing out water. There are four species: *viz.* 1. Balæna bo-ops, the pike-headed whale, has a double pipe in its snout, three fins, and a hard horny ridge on its back. The belly is full of longitudinal folds or rugæ. It frequents the Northern ocean. The length of one taken on the coast of Scotland, as remarked by Sir Robert Sibbald, was forty-six feet, and its greatest circumference twenty. This species takes its name from the shape of its nose, which is narrower and sharper pointed than that of other whales. 2. Balæna musculus has a double pipe in its front, and three fins; the under jaw is much wider than the upper one. It frequents the Scotch coasts, and feeds upon herrings. 3. Balæna mysticetus, the common or great Greenland whale, which has no fin on the back. This is the largest of all animals; it is even at present sometimes found in the northern seas ninety feet in length; but formerly they were taken of a much greater size, when the captures were

less frequent, and the fish had time to grow. Such is their bulk within the arctic circle : but in the torrid zone, where they are less molested, whales are still seen one hundred and sixty feet long. The head is very much disproportioned to the size of the body, being one-third of the size of the fish: the under lip is much broader than the upper. The tongue is composed of a very soft spongy fat, capable of yielding five or six barrels of oil. The gullet is very small for so vast a fish, not exceeding four inches in width. In the middle of the head are two orifices, through which it spouts water to a vast height, and with a great noise, especially when disturbed or wounded ; the eyes are placed towards the back of the head, being the most convenient situation for enabling them to see both before and behind ; as also to see over them, where their food is principally found. They are guarded by eye-lids and eye-lashes, as in quadrupeds; and the animals seem to be very sharp-sighted. Nor is their sense of hearing in less perfection ; for they are warned at a great distance of any danger preparing against them. It is true, indeed, that the external organ of hearing is not perceptible, for this might only embarrass them in their natural element ; but as soon as the thin scarf skin is removed, a black spot is discovered behind the eye, and under that is the auditory canal, that leads to a regular apparatus for hearing. In short, the animal hears the smallest sounds at very great distances, and at all times, except when it is spouting water, which is the time that the fishers approach to strike it. What is called whalebone, adheres to the upper jaw, and is formed of thin parallel laminæ, some of the longest four yards in length ; of these there are commonly 350 on each side, but in very old fish more. They breed only once in two years. Their fidelity to each other exceeds whatever we are told even of the constancy of birds. Some fishers, as Anderson informs us, having struck one of two whales, a male and a female, that were in company together, the wounded fish made a long and terrible resistance ; it struck down a boat with three men in it, with a single blow of its tail, by which all went to the bottom. The other still attended its companion, and lent it every assistance ; till, at last, the fish that was struck, sunk under the number of its wounds ; while its faithful associate, disdaining to survive the loss, with great bellowing, stretched itself upon the dead fish, and shared its fate. The whale goes with young nine or ten months, and is then fatter than usual, particularly when near the time of bringing forth. It is said that the embryo, when first perceptible, is about seventeen inches long, and white ; but the cub, when excluded, is black, and about ten feet long. She generally produces one young one, and never above two. When she suckles her young, she throws herself on one side of the surface of the sea, and the young one attaches itself to the teat. Nothing can exceed the tenderness of the female for her offspring. Even when wounded, she still clasps her young one ; and when she plunges to avoid danger, takes it to the bottom ; but rises sooner than usual, to give it breath again. The young ones continue at the breast for a year, during which time, they are called by the sailors, short-heads. They are then extremely fat, and yield above fifty barrels of blubber. The mother at the same time is equally lean and emaciated. 4. Balæna physalus, or fin fish, is distinguished from the common whale by a fin on the back, placed very low and near the tail. The length is equal to that of the common kind, but much more slender. It is furnished with whalebone in the upper jaw, mixed with hairs, but short and knotty, and of little value. The blubber also in the body of this kind is very inconsiderable. These circumstances, added to its extreme fierceness and agility, which render the capture very dangerous, cause the fishers to neglect it. The natives of Greenland, however, hold it in great esteem, as it affords a quantity of flesh which to their palate is very agreeable. The lips are brown, and like a twisted rope : the spout hole is seemingly split in the top of its head, through which it blows water with much more violence, and to a greater height, than the common whale. The fishers are not very fond of seeing it, for on its appearance the others retire out of those seas. It feeds on herrings and small fish. Inoffensive as the whale is, it is not without enemies. There is a small animal, of the shell-fish kind, called the whale-louse, that sticks to its body, as we see shells sticking to the foul bottom of a ship. This insinuates itself chiefly under the fins ; and whatever efforts the great animal makes, it still keeps its hold, and lives upon the fat, which it is provided with instruments to arrive at. The sword-fish, however, is the whale's most terrible enemy. At the sight of this little animal, the whale seems agitated in an extraordinary

PISCES.

Plate I.

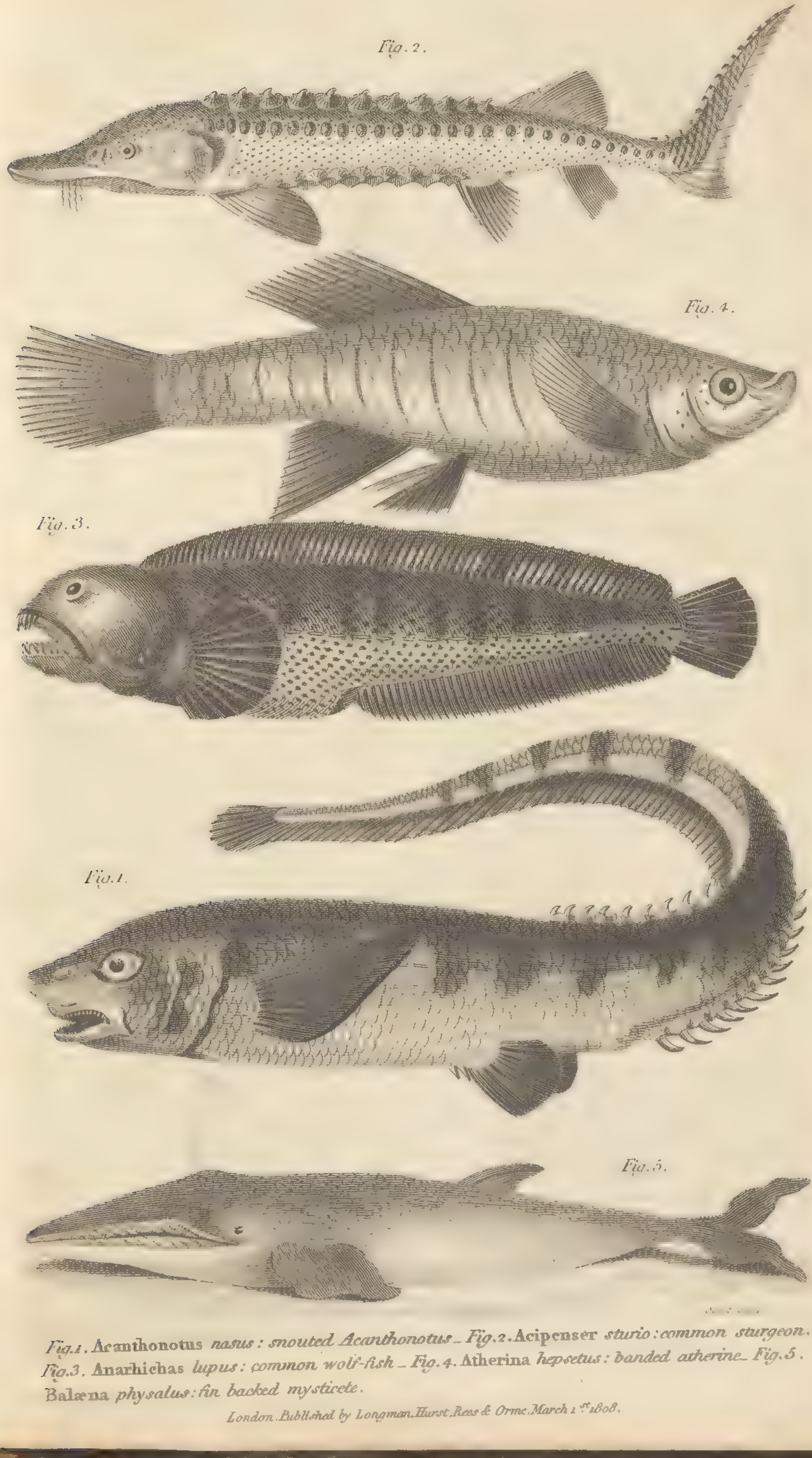

Fig. 1. Acanthonotus *nasus: snouted Acanthonotus* – *Fig. 2.* Acipenser *sturio: common sturgeon.* *Fig. 3.* Anarhichas *lupus: common wolf-fish* – *Fig. 4.* Atherina *hepsetus: banded atherine* – *Fig. 5.* Balæna *physalus: fin backed mysticete.*

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manner, leaping from the water as if with affright: wherever it appears, the whale perceives it at a ditsance, and flies from it in the opposite direction. The whale has no instrument of defence except the tail; with that it endeavours to strike the enemy; and a single blow taking place would effectually destroy its adversary: but the sword-fish is as active as the other is strong, and easily avoids the stroke; then bounding into the air, it falls apon its enemy, and endeavours not to pierce with its pointed beak, but to cut with its toothed edges. The sea all about is soon dyed with blood, proceeding from the wounds of the whale; while the enormous animal vainly endeavours to reach its invader, and strikes with its tail against the surface of the water, making a report at each blow louder than the noise of a canon. There is still another powerful enemy to this fish, which is called the oria or killer. A number of these are said to surround the whale in the same manner as dogs get round a bull. Some attack it with their teeth behind; others attempt it before: until, at last, the great animal is torn down, and its tongue is said to be the only part they devour when they have made it their prey. But of all the enemies of these enormous fishes, man is the greatest; he alone destroys more in a year than the rest in an age, and actually has thinned their numbers in that part of the world where they are chiefly sought. At the first discovery of Greenland, whales not being used to be disturbed frequently, came into the very bays, and were accordingly killed almost close to the shore; so that the blubber being cut off, was immediately boiled into oil on the spot. The ships, in those times, took in nothing but the pure oil and the whalebone, and all the business was executed in the country; by which means a ship could bring home the product of many more whales than she can according the present method of conducting this trade. The fishing also was then so plentiful, that they were obliged sometimes to send other ships to fetch off the oil they had made, the quantity being more than the fishing ships could bring away. But time and change of circumstances have shifted the situation of this trade. The ships coming in such numbers from Holland, Denmark, Hamburgh, and other northern countries, all intruders upon the English, who were the first discoverers of Greenland, the whales were disturbed; and gradually, as other fish often do, forsaking the place, were not to be killed so near the shore as before; but are now found, and have been so ever since, in the openings and space among the ice, where they have deep water, and where they go sometimes a great many leagues from the shore. The whale-fishery begins in May, and continues all June and July; but whether the ships have good or bad success, they must come away, and get clear of the ice, by the end of August; so that in the month of September at farthest they may be expected home; but a ship that meets with a fortunate and early fishery in May, may return in June or July. See Plate I. Pisces, fig. 5. Whale Fishery.

BALE, in commerce, is said of merchandizes packed up in cloth, and corded round very tight, in order to keep them from breaking, or preserve them from the weather. Most of the merchandize capable of this kind of package, designed for fairs or exportation, ought to be in bales, and too much care cannot be taken in packing them, to prevent their being damaged. The bales are always to be marked and numbered, that the merchants to whom they belong, may easily know them.

Bale *goods*, among the English merchants, are all such as are imported or exported in bales; but the French give that name to certain hardwares, and other sort of merchandise, which come to Paris, and are commonly made by bad workmen, of indifferent materials.

BALISTES, in natural history, a genus of fishes of the order Cartilagenei. The generic characters are: teeth several in both jaws; body compressed; abdomen carinated; skin tough, often reticulated by scale-like divisions. There are 24 species: of which we shall mention the following, *viz.* the B. moneceros, or unicorn file-fish, which is often two feet long or more; the body is of an oval shape, and possesses the power of inflating at pleasure the sides of the abdomen, by means of a pair of bony processes within that part; the skin is every where covered with minute spines, and the general colour is grey, inclining to brown on the upper parts, and varied with irregular, dusky, subtransverse, undulations and spots: immediately over the head just above they eyes, is a strong, single, recurved spine, of considerable length, and serrated on the hind part: both fins and tail are of a pale brown colour, the latter being marked by a few dusky bars. This fish is a native of the Indian and American seas, feeding chiefly on

crustaceous and testaceous marine animals. It is said to be a poisonous fish. B. vetula, or ancient file-fish, is likewise denominated the old wife fish, a name which it is supposed to have obtained from the appearance of the mouth when viewed in front, as well as from the slightly murmuring noise which it utters when first taken. B. maculatus, spotted file-fish; is of an oval shape; its length is about eighteen or twenty inches, sometimes as much as two feet; colour pale violet; skin strongly marked into lozenge-shaped reticulations; first dorsal fin three-rayed: the first very strong; ventral spines rough, and but slightly projecting; tail somewhat convex in the middle of the outline, with falcated tops; whole body, dorsal and anal fin marked with numerous round blue spots. Native of the Indian and American seas. B. undulatus, or black file-fish, is a native of the Indian seas, observed first about the shores of Sumatra by the enterprizing and highly meritorious traveller Mungo Park. From the mouth to the base of the pectoral fins run three red lines, and the body is obliquely undulated by twelve lines of the same colour. See Plate II. Pisces, fig. 1.

BALL, in the military art, comprehends all sorts of bullets for fire arms, from the cannon to the pistol.

Cannon-balls are made of iron; musket-balls, pistol-balls, &c. are of lead. The experiment has been tried of iron balls for pistols and fusees, but they are justly rejected, not only on account of their lightness, which prevents them from flying straight, but because they are apt to furrow the barrel of the pistol, &c.

Cannon-balls are always distinguished by their respective calibres: thus,

For a..	pound ball the diameter is
42	6.68
32	6.10
24	5.54
18	5.04
12	4.40
9	4.00
6	3.49
3	2.77
2	2.42
1	1.92

BALL *and socket* is an instrument made of brass, with a perpetual screw, so as to move horizontally, vertically, and obliquely; and is generally used for the managing of surveying insruments, and astronomical instruments.

BALLAD, in music, formerly a little history told in verse, and sung to the harp or viol, either by the author himself, or the jongleur, whose profession it was to follow the bard and sing his works. About a century since the word ballad began to imply a brief, simple tale, conveyed in three or four verses, set to a short and familiar air, in which sense it is now understood.

BALLANCE, or BALANCE, in mechanics, one of the simple powers which serves to find out the equality or difference of weight in heavy bodies. See MECHANICS.

BALLANCE *of trade*, a term applied to the money ballance to be paid by one nation trading and carrying on business with another. So far as the articles mutually exported and imported pay for each other, there is no balance; but on which ever side the exports fall short in their amount, that nation is said to have the ballance of trade against it. See TRADE.

BALLANCE, *hydrostatical.* See HYDROSTATICS.

BALLANCE *of a clock or watch.* See CLOCK-WORK and WATCH-WORK.

BALLANCE, *to*, in sea-language, to contract a sail into a narrower compass, and the term is applied particularly to the mizen of a ship, and the main-sail of those vessels in which it is extended by a boom. The operation of ballancing the mizen is performed by lowering the yard a little, then rolling up a small portion of the sail at the upper corner, and lashing it about one-fifth down towards the mast. A boom-sail is ballanced by rolling up a portion of the clue, or lower aftermost corner, and fastening it strongly to the boom.

BALLAST, a quantity of stones, gravel, or sand, laid in a ship's hold, to make her sink to a certain depth into the water, and sail upright, rendering her of a prodigious weight. The ballast is sometimes one quarter, one-third, or one-half, according to the difference of the bulk of the ship. Flat vessels require the most ballast. Ships are said to be in ballast, when they have no other loading. Masters of vessels are obliged to declare the quantity of ballast they bear, and to unload it at certain places. They are prohibited unloading their ballast in havens, roads, &c. the neglect of which prohibition has ruined many excellent ports. All ships and vessels taking in ballast on the river Thames are bound to pay the corporation of the Trinity-house for every ton carried to any ship in the coal trade 1*s.* and for every other British ship, 1*s.* 3*d.* For every ton carried to any foreign ship, 1*s.* 7*d.* The Trinity-house employ men, and regulate them, and their lighters are to be marked. The art of bal-

lasting, as it is called, consists in placing the centre of gravity, so as neither to be too high nor too low, too far forward nor too far aft, and that the surface of the water may nearly rise to the extreme breadth amidship, and thus the ship will be enabled to carry a good sail, incline but little, and ply well to the windward.

BALLET, in music, a theatrical representation of some tale or fable told in dance, or metrical action, accompanied with music. The artist who invents and superintends the rehearsal and peformance of the ballet is called the ballet-master.

BALLISTA, in antiquity, a military machine used by the ancients in besieging cities, to throw large stones, darts, and javelins.

It resembled our cross-bows, though much larger, and superior in force.

From this engine stones of a size not less than mill-stones were thrown with so great violence, as to dash whole houses in pieces at a blow. It is described thus: a round iron cylinder was fastened between two planks, from which reached a hollow square beam, placed crosswise, and fastened with cords, to which were added screws; at one end of this stood the engineer, who put a wooden shaft with a big head into the cavity of the beam: this done, two men bent the engine by drawing some wheels: when the top of the head was drawn to the utmost end of the cords, the shaft was driven out of the ballista, &c.

BALLOON, or BALLON, in a general sense, signifies any spherical hollow body, of whatever matter it be composed, or for whatever purposes it be designed.

Thus, with chemists, balloon denotes a round short-necked vessel, used to receive what is distilled by means of fire; in architecture, a round globe on the top of a pillar; and among engineers, a kind of bomb made of pasteboard, and played off in fire-works, either in the air or in the water, in imitation of a real bomb. Balloon, in the French paper trade, is a term for a quantity of paper, containing 24 reams. It is also the name of a sort of brigantine used in the kingdom of Siam.

BALLOON. See AEROSTATION.

BALLOTA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of the Verticillatæ, or Labiatæ. Essential character: calyx salver-shaped, five-toothed, ten-streaked: corolla upper-lip crenate, concave. There are six species. B. nigra is the black or stinking horehound, a hairy plant, with an upright brownish stem, about two feet in height. It is a perennial plant, common in most parts of Europe, in waste places and hedges, flowering in July. It is recommended in hysterical cases. In Gothland it is an universal remedy for cattle; but the Swedish plant is probably not the same as ours. The European sorts, being common stinking weeds, are never introduced into gardens.

BALLS, or BALLETS, in heraldry, a frequent bearing in coats of arms, usually denominated according to their colours, bezants, plates, hurts, &c.

BALM, or BAUM, in botany. See MELISSA.

BALNEUM, a term used by chemists to signify a vessel filled with some matter, as sand, water, or the like, in which another is placed that requires a more gentle heat than the naked fire.

BALSAM, or NATIVE BALSAM, an oily, resinous, liquid substance, flowing either spontaneously, or by means of incision, from certain plants of sovereign virtue in the cure of several disorders.

The term balsam, or balm, was originally confined to a thick fragrant juice, obtained from the amyris Gileadensis, and afterwards applied by chemists to all substances which possessed the same degree of consistence and a strong smell, whether natural or artificial. The word balsam originally implied a substance possessing a certain degree of fluidity: but now there are two classes of balsams; the one fluid, and the other solid and brittle. A balsam, then, is a substance which possesses the general properties of a resin; but which, when heated or digested in acids, yields a portion of benzoic acid. See BENZOIN.

Chemists, in general, have considered them as combinations of a resin with benzoic acid; but Mr. Hatchett has made it probable, that the acid is formed at the time of its separation. They are insoluble in water; but when boiled in that liquid often give out a portion of benzoic acid. Alcohol and ether dissolve them readily. The strong acids, likewise, dissolve them, and during the solution a portion of benzoic acid is separated. Nitric acid, in some cases, evolves likewise traces of prussic acid. The alkalies act upon them nearly as on the resins. They may be divided into two classes; namely, liquid and solid balsams.

Liquid balsams. The liquid balsams at present known are five in number; namely,

1. Opobalsamum.
2. Copaiva.
3. Tolu.
4. Peru.
5. Styrax.

1. Opobalsamum, or balm of Gilead.—This balsam is obtained from the amyris Gileadensis, a tree which grows in Arabia, especially near Mecca. It is so much valued by the Turks, that it is seldom or never imported into Europe. We are, of course, ignorant of its composition. It is said to be at first turbid and white, and of a strong aromatic smell, and bitter, acrid, astringent taste; but by keeping, it becomes limpid and thin, and its colour changes first to green, then to yellow, and at last it assumes the colour of honey, and the consistence of turpentine. It is also very tenacious and glutinous, sticking to the fingers, and may be drawn into long threads. The mode of ascertaining the purity of this balsam at Cairo and Mecca is to drop it into a cup of clear cold water; if it remain in one place on the surface, it is of little or no value, but if it extend itself like a skin over the whole surface, (and this skin is even and almost transparent, and may be taken off the water with a hair,) it is of great worth. The balsam of Gilead principally comes from Arabia Petræa, from whence the Arabs carry it to Mecca for sale, during the stay of the caravans from Egypt and Turkey. It grows also in the Holy Land, but not without much culture and attention, whereas in Arabia it grows without cultivation. It is the produce of a species of the amyris, rising to the height of the pomegranate tree, to which it has a great resemblance, both in its branches and flowers. See Amyris. The balsam is obtained by incision during the summer months, flowing over in a viscous juice, called Opobalsamum. It is white when it comes from the tree, and changes first to a green, and afterwards to a gold colour.

2. Copaiva.—This balsam is obtained from the Copaifera officinalis; a tree which grows in South America, and some of the West Indian islands. It exudes from incisions made in the trunk of the tree. The juice thus obtained is transparent, of a yellowish colour, an agreeable smell, a pungent taste, at first of the consistence of oil, but it gradually becomes as thick as honey. Its specific gravity is 0.950. When mixed with water and distilled, there comes over with the water a very large portion of volatile oil. The oil ceases to come over before all the water has passed into the receiver. The residuum, of course, consists of two substances; namely, the watery portion, and a greyish yellow substance, lying at the bottom of the vessel, which, on exposure to the air, dries, and becomes brittle and transparent. When heated, it melts, and possesses the characters of a resin. Nitric acid acts upon this balsam with considerable energy. When one part of the balsam is mixed with four parts of nitric acid and two parts of water, and heated, a yellowish solution is formed, similar to the original balsam, but darker. When distilled, there comes over with the liquid that passes into the receiver an apple-green oil, which lines the helm of the retort. The nature of the residue was not examined. When treated with sulphuric acid, it yields a portion of artificial tannin. Whether this balsam yields benzoic acid has not been ascertained. Its properties are rather against the probability of its doing so. Indeed it bears a striking resemblance to turpentine in many respects; and ought, along with it, to constitute a class of bodies intermediate between volatile oils and resins, to which the name of turpentines might be given.

3. Balsam of Tolu.—This substance is obtained from the Toluifera balsamum, a tree which grows in South America. The balsam flows from incisions made in the bark. It comes to Europe in small gourd shells. It is of a reddish brown colour and considerable consistence, and when exposed to the air it becomes solid and brittle. Its smell is fragrant, and continues so even after the balsam has become thick by age. When distilled with water, it yields very little volatile oil, but impregnates the water strongly with its taste and smell. A quantity of benzoic acid sublimes, if the distillation be continued. Mr. Hatchett found it soluble in the alkalies, like the rest of the balsams. When he dissolved it in the smallest possible quantity of lixivium of potash, it completely loses its own odour, and assumes a most fragrant smell, somewhat resembling that of the clove pink. "This smell," Mr. Hatchett observes, "is not fugitive, for it is still retained by a solution which was prepared in June, and has remained in an open glass during four months." When digested in sulphuric acid, a considerable quantity of pure benzoic acid sublimes. When the solution of it in this acid is evaporated to dryness, and the resi-

dunm treated with alcohol, a portion of artificial tannin is obtained; the residual charcoal amounts to 0.54 of the original balsam.

4. Balsam of Peru is obtained from the Myroxylon Peruiferum. The tree is full of resin, and the balsam is obtained by boiling the twigs in water. It has the consistency of honey, a brown colour, an agreeable smell, and a hot acrid taste. When boiled with water for some time, the liquid separated by the filter reddens vegetable blues, and deposits crystals of benzoic acid on cooling. The water contains no other substance. When distilled with water, it yields a very small quantity of reddish limpid oil. A saturated solution of carbonate of soda forms with this balsam a thick mass. When diluted with water and heated, a portion is dissolved. The solution, when saturated with sulphuric acid, deposits crystals of benzoic acid. One part of the balsam, treated with one part of potash dissolved in four parts of water, formed an opaque solution, which gradually separated into two portions: the uppermost, a clear oil, with some grey flakes at its lower surface; the undermost, a dark brownish red opaque solution. This last solution, when saturated with sulphuric acid, let fall a resinous-like substance, dissolved by boiling, while benzoic acid crystallized. Nitric acid acts upon the balsam with energy, and gives it an orange yellow colour, when assisted by heat. When distilled with a sufficient quantity of this acid diluted, the liquid in the receiver smells of bitter almonds. When this balsam is treated with sulphuric acid, artificial tannin is also formed, and the residual charcoal amounts to no less than 0.64 of the original weight of the balsam.

5. Styrax.—This is a semifluid juice, said to be obtained from the Styrace officinale, a tree which grows in Virginia, Mexico, and some other parts of America. It is prepared in the island Cobrass, in the Red Sea, from the bark of a tree called rosa mallos by the natives, and considered by botanists as the same with the American species. The bark of this tree is boiled in salt water to the consistence of birdlime, and then put into casks. Bouillon la Grange has published an account of its properties. Its colour is greenish, its taste aromatic, and its smell agreeable. It is easily volatilized by heat. When treated with water benzoic acid is dissolved. It is totally soluble in alcohol, except the impurities. When exposed to the air, it becomes harder, and absorbs oxygen. When distilled, it yields an acidulous water, having the odour of benzoic acid, a limpid colourless hot oil, a solid coloured oil, benzoic acid, and a mixture of carbonic acid and carburetted hydrogen. The charcoal is light, and contains some oil.

Solid balsams. The solid balsams at present known are only three in number; namely,

1. Benzoin.
2. Storax.
3. Dragon's blood.

1. Benzoin.—This substance is the produce of the styrax benzoe, a tree which grows in Sumatra, &c. and which has been described by Dr. Dryander. Benzoin is obtained from this tree by incision; a tree yielding three or four pounds. It is a solid brittle substance, sometimes in the form of yellowish white tears, joined together by a brown substance, and sometimes in the form of a brown substance, not unlike common rosin. It has a very agreeable smell, which is increased by heating the benzoin. It has little taste. Its specific gravity is 1.092. Alcohol dissolves it when assisted by a gentle heat, and forms a deep yellow solution inclining to reddish brown. When this solution is diluted with water, the benzoin precipitates in the form of a white powder. It is precipitated also by muriatic and acetic acids, but not by the alkalies. A few drops of sulphuric acid likewise precipitate the benzoin; but an additional quantity redissolves it, and forms a liquid of the colour of port wine. Nitric acid acts with violence on benzoin, and converts it into an orange-coloured mass. When assisted by heat the acid dissolves the benzoin; and as the solution cools, crystals of benzoic acid gradually separate. Mr. Hatchett ascertained that by this process a quantity of artificial tannin is formed. Sulphuric acid dissolves benzoin, while benzoic acid sublimes; the solution is at first a deep red. By continuing the digestion, a portion of artificial tannen is formed, and the charcoal evolved amounts to 0.48 of the benzoin dissolved. Acetic acid dissolves benzoin without the assistance of heat. When heat is applied, the solution, as it cools, becomes turbid; owing to the separation of benzoic acid. Benzoin is dissolved by a boiling lixivium of the fixed alkalis; a dark brown solution is formed, which becomes turbid after some days' exposure to the air. Ammonia likewise dissolves benzoin sparingly.

2. Storax.—This is the most fragrant of all the balsams, and is obtained from the

styrax officinalis, a tree which grows in the Levant, and it is said also in Italy. Sometimes it is in the state of red tears; and this is said to be the state in which it is obtained from the tree. But common storax is in large cakes, brittle, but soft to the touch, and of a reddish brown colour. It dissolves in alcohol.

3. Dragon's blood.—This is a brittle substance of a dark red colour, which comes from the East Indies. There are two sorts of it; one in small oval drops or tears of a fine deep red, which becomes crimson when the tears are reduced to powder; the other is in larger masses, some of which are pale red, and others dark. It is probably obtained from different kinds of trees; the calamus draco is said to furnish most of what comes from India. The dracæna draco and the pterocarpus draco are also said to furnish it. Dragon's blood is brittle and tasteless, and has no sensible smell. Water does not act upon it, but alcohol dissolves the greatest part, leaving a whitish red substance, partially acted upon by water. The solution has a fine deep red colour, which stains marble, and the stain penetrates the deeper the hotter the marble is. It dissolves also in oils, and gives them a deep red colour also. When heated it melts, catches flame, and emits an acid fume similar to that of benzoic acid. When digested with lime, a portion of it becomes soluble in water, and it acquires a balsamic odour.

Balsam. See Pharmacy.

BALSAMINA, in botany. See Impatiens.

BALSAMITA, in botany, a genus of the Syngenesia Æqualis class and order. Receptacle naked; calyx imbricate. Four species, found in Crete, Nice, Barbary, and Italy.

BALTIMORA, in botany, so named by Linnæus in honour of Lord Baltimore, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order, compositæ oppositifoliæ: corymbiforcæ Jussieu. Essential character: calyx cylindric, many-leaved: ray of the corolla five-flowered; receptacle chaffy. One species, B. recta, which is a native of Maryland; an annual plant, about two feet high; it flowers in June and July.

BAMBOE, or Bambou, a plant in the Indies, which multiplies very much by its root, from which springs a branchy tuft after the manner of the European reeds. It is of the largest kind of cane, and decreases gradually to the top, where it bears a blossom like our reeds. The bamboe is a species of arundo. See Arundo.

The bamboo-cane grows naturally almost every where within the tropical regions; it is common in many parts of Asia, as China, Cochin-China, Tonquin, Cambodia, Japan, Ceylon, the Peninsula of India and the islands. This useful plant has been long introduced into the West Indies. There are some fine specimens of bamboo in the Botanical Garden at Liverpool. Scarcely any plant serves for more useful purposes than the bamboo where it grows naturally. In the East Indies great use is made of it in building, and the houses of the meaner people are almost entirely composed of it. Bridges are also made of it, masts for their sailing vessels, boxes, cups, baskets, mats, and a great variety of other utensils and furniture. Paper is also made from it by bruising and steeping it in water, and thus forming it into a pulp. It is the common fence for gardens and fields, and is frequently used as pipes for conveying water. The leaves are generally put round the chests of tea which are sent to Europe from China, as package fastened together, so as to form a kind of mat. The tops of the tender shoots are frequently pickled in the West Indies. In the cavities of the bamboo is found at certain seasons a concrete white substance, which the Arabian physicians hold in high estimation.

BAN, in law, a public notice applied particularly to the publication of intended marriages, which must be done on three several Sundays previously to marriage, that if any shew just cause against such marriage they may have an opportunity to set forth their objections.

BANARA, in botany, a genus of the Dodecandria Monogynia class and order. Natura order, columniferæ; tiliacæ, Jussieu. Essential character: calyx six-parted, permanent; corolla six-petalled; germ seated on a glandule; stigma headed; berry globose, one-celled, and many-seeded. One species, B. guiannois, a tree of ten feet or more in height, and about seven inches in diameter, with a greyish bark, and a whitish light wood; a native of the island of Cayenne; flowering in May, and bearing fruit in July.

BANDAGE, in surgery, a fillet, a roller, or swathe, used in dressing and binding up wounds, restraining dangerous hæmorrhages, and in joining fractured or dislocated bones. See Surgery.

BANDEROLL, a little flag in form of a guidon, extended more in length than breadth, used to be hung out on the masts of vessels, &c.

BANE, in law, destruction, as he who is the cause of another man's death is said to be *le bane*, that is a malefactor. Bracton.

BANERET. See BANNERET.

BANIAN *days*, a sea term among sailors, to signify those days in which they have no meat. It was probably derived from the practice of the Banians, which see.

BANIANS, a religious sect in the empire of the Mogul, who believe a metempsychosis, and will therefore eat no living creature, nor even kill noxious animals; but endeavour to release them when in the hands of others.

The Banians are said to be so fearful of having communication with other nations, that they break their cups if one of a different religion has drank out of them, or even touched them. It is said that if they happen to touch one another they purify and wash themselves before they eat, or enter their own houses. They carry, hanging to their necks, a stone called tamberane, as big as an egg, and perforated in the middle, through which run three strings; this stone, they say, represents their great god, and upon that account they have great respect shewn them by all the Indians.

BANISHMENT is the quitting of the realm: there are two kinds of it, one voluntary, called abjuration, and the other upon compulsion for some offence. By the habeas corpus act no subject of this realm, who is an inhabitant of England, Wales, or Berwick, shall be sent prisoner into Scotland, Ireland, Jersey, Guernsey, or place beyond seas, where they cannot have the protection of the common law, for by it every Englishman may claim a right to abide in his own country so long as he pleases, and not be banished or driven from it but by sentence of the law.

BANISTERIA, in botany, named after the Rev. John Banister, a curious botanist, who lost his life in the search of plants in Virginia; a genus of the Decandria Trigynia class and order. Natural order, trihilatæ, malphigiæ. Essential character: calyx five-parted, with melliferous pores at the base on the outside; petal roundish, with claws; stigmas leave-shaped; seeds three-winged, with membranes. There are 24 species, all of which are inhabitants of very hot climates, chiefly in America, from Brazil to Louisiana, particularly the islands. They are shrubs mostly with twining stems, adorning the woods with the beauty of their flowers, and the variety of their opposite leaves. They cannot be preserved in England unless they are kept in a bark stove. They are propagated by seeds, which must be procured from the countries where they grow naturally. The seeds must be fully ripe, and put into sand or earth in which they should be sent to England, otherwise they will not grow: when they arrive they should be immediately sown in pots; and if it happen in autumn or winter the pots should be plunged into a hot-bed of tanner's bark, and secured from frost and wet till spring, when they must be removed to a fresh hot-bed, which will bring up the plants; but if they should not appear the first year, the pots should be preserved till the next spring, as the plants may come up then. When the plants appear they must be treated like other tender plants from the same countries.

BANK, in commerce, the name usually given to establishments which receive the money of private persons, to keep it in security or improve it at interest, till those to whom it belongs have occasion to draw it out again. They are generally formed by a number of monied persons, who, for carrying on the business of exchanging or dealing in bullion, money, and bills, advance a considerable sum as a joint capital, which also forms a security to those who deposit money with them. The convenience of such institutions in facilitating commercial transactions, has caused them to be erected in almost every considerable city of Europe. The bank of Venice was established about the year 1157, the bank of Genoa in 1345, the bank of Amsterdam in 1609, the bank of Hamburgh in 1619, the bank of Rotterdam in 1635, the bank of England in 1694, the bank of Scotland in 1695, the bank of France in 1716.

BANK *of England*, was projected by Mr. W. Paterson, a merchant, who in conjunction with others arranged the establishment for which with some difficulty they obtained the sanction of parliament. The charter was executed July 27, 1694, and was granted for the term of twelve years, the corporation being then determinable on a year's notice. The original capital subscribed was 1,200,000*l.* which they lent to government at 8 per cent. interest, with an allowance of

4000*l.* per ann. for their expenses of management.

In less than two years from its establishment the company was involved in much difficulty from the bad state of the silver coin, and the great discount to which all public securities had fallen: the impossibility of getting a sufficient supply of cash during the re-coinage, reduced them to the necessity of paying their notes by small instalments, and of issuing bonds, bearing interest, in exchange for their cash notes. These difficulties, however, were overcome by prudent management, and the responsibility and reputation of the bank became fully established. The term of the charter was, in 1706, extended to five years beyond the original period, in consideration of the company having undertaken to circulate for government exchequer bills to the amount of 1,500,000*l.* and it has since been further extended at different times, *viz.*

In 1709	to 1st of August	1732
1713	....	1742
1742	....	1764
1763	....	1786
1781	....	1812
1800	....	1833

On all these occasions the company have either paid a considerable sum, or advanced a greater amount by way of loan to government, as a consideration for the renewal of their exclusive privileges, and for the advantages they derive from acting as the agents for government in all money transactions of any importance. Their chief privilege consists in the prohibition of all other companies or partnerships of more than six persons, from issuing bills or notes payable on demand, or for any time less than six months.

The total permanent debt due from government to the bank is 11,686,800*l.* bearing 3 per cent. interest; but the capital stock of the company is 11,642,400*l.* on which they pay a dividend of 10 per cent. per ann. to the proprietors.

The notes of the bank of England are the representative of money in all the commercial transactions of London and its vicinity, and from the vast magnitude of the payments in which they are employed, the total amount in circulation, which till within a few years was never made public, was generally thought to be much greater than it has since appeared to have been. The total amount of bank notes in circulation on the 25th of Feruary, 1787, was 8,688,570*l.* which on the 25th of February, 1793, had increased to 11,451,180*l.* Soon after this period the temporary annual advances which the bank had long been accustomed to make to government were increased; while an advance in the price of gold, in consequence of the great exportation of coin and bullion to Germany and Ireland, greatly reduced the quantity in the hands of the bank, and consequently rendered it impracticable to maintain the same amount of notes in circulation. An alarm of invasion in the beginning of the year 1797 greatly increased the demands on the bank for cash, and it was deemed necessary for the government to interfere and authorise a suspension of payment in cash for bank notes, for a limited period: the continuance of the suspension was at first renewed annually, and afterwards till the return of peace. In order to supply a substitute for coin for making small payments, the bank issued notes of 2*l.* and 1*l.* each, and as the demand for notes of this description has increased, the total amount of bank notes in circulation has become considerably greater than previous to the suspension of issuing cash, *viz.*

On the 1st of Feb.	1805,	£18,397,880
....	1806,	17,293,570
....	1807,	16,621,390

From the reports of the secret committee appointed in 1797 to investigate the affairs of the bank, it appeared that on the 25th of February, in that year, there was a balance of 3,826,903*l.* and on the 11th of November a balance of 3,839,550*l.* in favour of the company; their profits since must have been greater than while they were obliged to maintain a large stock of cash to answer their notes, which has enabled them to make several occasional dividends to their proprietors, and at Lady-day, 1807, to raise their usual dividend from 7 per cent. which it had been for the last 19 years to 10 per cent.

The profits of the company arise from the interest received from government on the permanent debt, and on their annual advances on exchequer bills and treasury bills of exchange; from their allowance for receiving the contributions to loans, and for paying the dividends on the public funds; from dealing in bullion, and discounting mercantile bills of exchange, and other sources of less importance.

The concern is under the management of a governor, deputy governor, and twenty-four directors, who are elected annually. 500*l.* bank stock entitles the proprietor to a vote at the general courts, and no proprietor

is entitled to more than one vote for any sum whatever.

Bank *of Scotland*, was established under the superintendance of Mr. W. Paterson, from whom the plan of the bank of England originated. It was erected by an act of the parliament of Scotland in 1695, and although its capital stock was only 1,200,000*l.* Scots, or 100,000*l.* sterling; it was soon found very beneficial to the commerce of North Britain. In 1774 they were authorised to increase their capital 1,200,000*l.* Scots, or 100,000*l.* sterling; and in 1784 another addition was made of the same amount. By an act passed in 1792, they were impowered to double the existing capital, which thus became equal to 600,000*l.* sterling, and in 1794 a further addition was made equal to 400,000*l.* sterling; the total capital thus became 12,000,000*l.* Scots, or 1,000,000*l.* sterling. The company is under the management of a governor, a deputy governor, twelve ordinary directors, and twelve extraordinary directors.

Bank, *Royal, of Scotland*, was established by charter in 1727, with a capital of 151,000*l.* sterling. The public revenues of Scotland are paid into this bank, and it is under the management of a governor, deputy governor, and sixteen directors.

Bank *of Ireland*, was established in the year 1781. The original capital was only 600,000*l.* and the company's privileges were determinable on twelve month's notice after the 1st of January, 1794. Previous to this period the capital was increased to 1,000,000*l.* and the term extended to the 1st of January, 1816; and by a subsequent act they were impowered to augment their capital to 1,500,000*l.* In the original act by which this bank was established, it was directed that they should not borrow or give security by bill, bond, note, covenant, or agreement, under their common seal or otherwise, for any sum exceeding their capital; and a clause to a similar purport, though not in the same precise words, was included in the subsequent acts. Since the suspension of payment in cash, however, the total amount of the notes of the bank of Ireland in circulation has been greatly increased, so that on the 1st of January, 1797, they amounted only to 621,917*l.* 6*s.* 4*d.* including bank post bills, whereas on the 1st of February, 1806, the amount of their notes of 5*l.* value and upwards was 1,676,118*l.* 11*s.* 2½*d.* and of notes under 5*l.* value 811,454*l.* 10*s.* 9*d.* making together 2,487,573*l.* 1*s.* 11½*d.*

The bank receives interest at 5 per cent. from the government, on their permanent and temporary loans; and an allowance for management of such part of the public debt as has been made transferrable at the bank of Ireland.

Bank, in natural history, denotes an elevation of the ground, or bottom of the sea, so as sometimes to surmount the surface of the water, or, at least, to leave the water so shallow, as usually not to allow a vessel to remain afloat over it.

In this sense, bank amounts to much the same with flat, shoal, &c. There are banks of sand, and others of stone, called also shelves, or rocks. In the North sea, they also speak of banks of ice, which are large pieces of that matter floating.

A long narrow bank is sometimes called a rib.

The bank, absolutely so called, or the main bank, or great bank, denotes that of Newfoundland, the scene of the cod fishery.

It is called the great bank, not only by reason of its vast extent, being, according to the English computation, 200 miles long, and, according to the French, 100 leagues, or 300 miles; but also on account of several lesser banks near it, where cod are also caught.

Banks, on the sea coast, are usually marked by beacons, or buoys, and in charts they are distinguished by little dots, as ridges of rocks are by crosses. An exact knowledge of the banks, their extent, and the depth of water on them, makes a most essential part of the science of a pilot, and master of a ship: if the vessel be large, and draw much water, great attention will be necessary to keep clear of the banks; on the contrary, if it be small, the same banks afford a sure asylum, where it may brave the largest and stoutest vessels, which dare not follow it here. By means of this barrier many small craft have escaped their enemies.

Bank, in vessels which go with oars, is used for the bench where the rowers are seated; popularly called by our seamen the thaught.

In this sense we read of banks of gallies, of galeasses, of galliottes, of brigantines, and the like.

The Venetian gondolas have no banks; for the watermen row standing.

The common gallies have 25 banks, that is, 25 on each side, in all 50 banks, with one oar to each bank, and four or five men to each oar.

The galeasses have 32 banks on a side, and six or seven rowers to a bank.

BANKAFALET, a game at cards, which

being cut into as many heaps as there are players, every man lays as much money on his own card as he pleases; and the dealer wins or loses as many as his card is superior or inferior to those of the other gamesters.

The best card is the ace of diamonds; the next to it, the ace of hearts; then the ace of clubs; and, lastly, the ace of spades: and so of the rest of these suits in order, according to their degree.

The cheat lies in securing an ace, or any other sure winning card; which are somehow marked, that the sharper may know them.

BANKER, a person who traffics and negotiates in money, who receives and remits money from place to place, by commission from correspondents, or by means of bills or letters of exchange.

In France, it is not requisite that a man be a merchant, in order to carry on banking: for that trade is permitted to all sorts of persons, even to foreigners, so far as relates to foreign banking, or dealing by exchange.

In Italy, the trade of a banker does not derogate from nobility, which is the reason why most of the younger sons of the quality apply themselves to that employment, in order to support their families. The monied goldsmiths, in the reign of king Charles the Second, first acquired this name.

The Romans had two sorts of bankers, whose office was much more extensive than that of the bankers among us; theirs being that of public affairs, in whom were united the functions of a broker, agent, banker, and notary, managing the exchange, taking in money, assisting in buying and selling, and drawing the writings necessary on all these occasions.

BANKRUPT, a trader whom misfortune or extravagance has induced to commit an act of bankruptcy. The benefit of the bankrupt laws is allowed to none but actual traders, or such as buy and sell, and gain a livelihood by so doing.

Requisites to constitute a trading, the merchandising, or buying and selling, must be of that kind, whereby the party gains a credit upon the profits of an uncertain capital stock. Manufacturers, or persons purchasing goods or raw materials to sell again, under other forms, or meliorated by labour; as bakers, brewers, butchers, shoemakers, smiths, tanners, tailors, &c. are also within the statutes.

The following description of persons are not within the statutes of bankruptcy; *viz.* proprietors or persons having an interest in land, if buying and selling to whatever extent, for the purposes of disposing merely of the produce and profits of such land; graziers and drovers; owners of coal mines, working and selling the coals; owners or farmers of alum rocks; farmers who make cheeses for sale; or those who sell cider made from apples of their own orchard.

In all such cases, and others of a similar nature, where the several materials are purchased, and even some kind of manufacture exercised; yet as this is the necessary and customary mode of receiving the benefit arising from the land, such persons are not held to be traders within the statutes; nor are persons buying and selling bank stock or government securities. Buying or selling only, will neither singly constitute trading; neither will a single act of buying and selling, or drawing, or redrawing bills of exchange, merely for the purpose of raising money for private occasions, and not with a view to gain a profit upon the exchange. Being a part-owner in a ship, barge, or waggon, does not constitute a trader; nor holding a share or interest in a joint stock with others who trade, unless he share in the profit and loss upon the disposition of the capital. The merchandise must also be general, and not in a qualified manner only, as victuallers or innkeepers; schoolmasters; commissioners of the navy, who victual the fleet by private contract; the king's butler, steward, or other officers; officers of excise or custom; sutlers of the armies; butlers; stewards of inns of court; clergymen; &c. as acting in such capacities merely, are not liable to be made bankrupts; the buying and selling in such cases not being general, but in the exercise of particular employments. Neither, upon the same principle, are receivers of the king's taxes, or persons discounting exchequer bills. If the parties above enumerated, however, bring themselves within the bankrupt laws in any other respect, they will be liable to their operation, although they should evidently not profit by trading, or such trading should be illegal; although the trading should not be wholly carried on in England, buying only in England, and selling beyond sea. Any person, native, denizen, or alien, residing in any part of the British dominions, or in foreign countries, though never a resident trader in England; yet if he be a trader, and on coming to England commit an act of bankruptcy, he will be subject to the bankrupt laws.

No one can be a bankrupt, on account of any debt, which he is not compellable by law to discharge, as infants or married women. And if a single woman be a trader, and committing any act of bankruptcy, afterwards marry, a commission issued against her after such marriage, cannot be supported. But according to the custom of London, where a married woman is sole trader, she is held liable to a commission of bankruptcy like a feme sole.

Acts of bankruptcy. Departing the realm. This must be done with intent to defraud or delay creditors; when it appears that there was no such intention, it will not be a departure within the meaning of the statutes.

Departing from the dwelling house. Such departure must also be with intent to defraud and delay creditors; for the departure with an intent to delay has been held insufficient, without an actual delay of some creditors.

Beginning to keep the house, the being denied to a creditor, who calls for money; but an order to be denied, is not enough without an actual denial, and that also to a creditor who has a debt demandable at the time.

Voluntary arrest, not only for a fictitious debt, but even for a just one, if done with the intent to delay creditors, is an act of bankruptcy.

Suffering outlawry, with an intent to defraud the creditors; but this will not make a man a bankrupt, if reversed before issuing a commission, or for default of proclamations after it, unless such outlawry were originally fraudulent.

Escaping from prison. Being arrested for a just debt of 100*l.* or upwards, and escaping against the consent of the sheriff.

Fraudulent procurement of goods to be attached or sequestered.

A fraudulent execution, though avoid against creditors, is not within the meaning of the words attachment, or sequestration, used in the statute; because they relate only to proceedings used in London, Bristol, and other places.

Making any fraudulent conveyance. Any conveyance of property, whether total or partial, made with a view to defeat the claims of creditors, is a fraud, and if it be by deed, is held to be an act of bankruptcy.

A conveyance by a trader of all his effects and stock in trade by deed, to the exclusion of any one or more of his creditors, has been ever held to be an act of bankruptcy.

A mortgage (amongst other things) of all the stock in trade of a tradesman, was held to be an act of bankruptcy, as being an assignment of all the stock in trade, without which he could carry on no business.

A conveyance by a trader, of part of his effects, to a particular creditor, carries no evidence whatever of fraud, unless made in contemplation of bankruptcy.

Being arrested for debt, lying in prison two months or more, upon that or any other arrest, or detention in prison for debt, will make the party a bankrupt, from the time of the first arrest; but where the bail is fairly put in, and the party at a future day surrenders in discharge of his bail, the two months are computed from the time of the surrender.

BANKRUPTCY, *proceedings of,* under a commission. The Lord Chancellor is empowered to issue a commission of bankrupt, and is bound to grant it as a matter of right. By 5 Geo. II. c. 30, no commission can issue, unless upon the petition of a single creditor, to whom the bankrupt owes a debt, which shall amount to 100*l.* the debt of two or more, being partners, shall amount to 150*l.* and of three or more to 200*l.*

If the debt against the bankrupt amount to the sum required, it is not material, though the creditor should have acquired it for less.

If a creditor to the full amount, before an act of bankruptcy committed, receive, after notice of the bankruptcy, a part of his debt, such payment, being illegal, cannot be retained, and the original debt remains in force, and will support a commission.

The debt must be a legal, and not an equitable one, and if the legal demand be not in its nature assignable, the assignee cannot be the petitioning creditor, as the assignee of a bond.

If the creditor, for a debt at law, have the body of his debtor in execution, he cannot at the same time sue out a commission upon it; that being, in point of law, a satisfaction for the debt.

Of opening the commission. When the commissioners have received proof of the petitioning creditor's debt, the trading, and act of bankruptcy, they declare and adjudge the party a bankrupt. They are authorized to issue a warrant under their hands and seals, for the seizure of all the bankrupt's effects, books, or writings, and for that purpose to enter the house, or any other place belonging to the bankrupt.

Such debts only can be proved under a commission, as were either debts certainly

payable, and which existed at the time of the bankruptcy, or which, although originally contingent, yet, from the contingency happening before the bankruptcy, were become absolute. In every case the amount of the debt must be precisely ascertained.

Time and method of proving. Creditors were formerly precluded from proving after four months, but the court now, except in cases of gross negligence, allows them to come in at any time, whilst any thing remains to be disposed of. The usual proof required, is the oath of the creditor himself, either in person, or by affidavit, if he live remote from the place of meeting, or reside in foreign parts. 5 Geo. II.

Corporations, or companies, are generally admitted to prove by a treasurer, clerk, or other officer duly authorized.

Of the assignees. Immediately after declaration of the bankruptcy, the commissioners are to appoint a time and place for the creditors to meet and choose assignees; and are directed to assign the bankrupt's estate and effects to such persons as shall be chosen by the major part in value.

The powers and duties of assignees are principally those of collecting the bankrupt's property, reducing the whole into ready money, and making distribution as early as possible. One assignee is not answerable for the neglect of another. Assignees, if they act improperly, are not only liable at law to the creditors for a breach of trust, but may be removed on account of misbehaviour, &c. by petitioning the Lord Chancellor. Upon the removal of an assignee, he is directed to join with the remaining one, in assignment to the latter and new assignee.

Provisions for wife, children, &c. By the statute of Elizabeth, the commissioners may assign any lands, &c. that the bankrupt shall have purchased jointly with his wife, and, the assignment shall be effectual, against the bankrupt, his wife, or children; but this shall not extend to conveyances made before the bankruptcy, bona fide, and not to the use of the bankrupt himself only, or his heirs, and where the party to the conveyance are not privy to the fraudulent purposes to deceive the creditors.

Examination of the bankrupt. By the 5th Geo. II. the commissioners are empowered to examine the bankrupt, and all others, as well by parole, as by interrogations in writing. The said statute requires the bankrupt to discover all his estate and effects, and how, and to whom, and in what manner, on what consideration, and at what time, he has disposed of them; and all books of papers, and writings relative thereto, of which he was possessed or interested, or whereby he or his family may expect any profit, advantage, &c. and on such examination he shall deliver up to the commissioners all his effects, (except the necessary wearing apparel of himself, his wife, and children,) and all books, papers, and writings relating thereto.

With respect to his privileges from arrest. By the above act, the bankrupt shall be free from all arrest in coming to surrender, and from his actual surrender to the commissioners for and during the 42 days, or the further time allowed to finish his examination, provided he was not in custody at the time of his surrender.

Books and papers. By 5 Geo. II. c. 30. the bankrupt is entitled, before the expiration of the 42 days, or enlarged time, to inspect his books and papers, in the presence of the assignees, or some person appointed by them, and make such extracts as he shall deem necessary.

Power of commissioners in case of contumacy. The statutes empower the commissioners to enforce their authority by commitment of the party, in the following cases: persons refusing to attend on the commissioners' summons; refusing to be examined, or to be sworn, or to sign and subscribe their examination; or not fully answering to the satisfaction of the commissioners.

Of the certificate. By the 5 Geo. II. a bankrupt surrendering, making a full discovery, and in all things conforming to the directions of the act, may with the consent of his creditors, obtain a certificate.

If the commissioners certify his conformity, and the same be allowed by the Lord Chancellor, his person, and whatever property he may afterwards acquire, will be discharged and exonerated, from all debts owing by him at any time he became a bankrupt. But no bankrupt is entitled to the benefit of the act, unless four parts in five, both in number and value, of his creditors, who shall be creditors for not less than 20*l*. respectively, and who shall have duly proved their debts under the commission, or some other person duly authorized by them, shall sign the certificate.

Of the dividends. The assignees are allowed four months from the date of the commission, to make a dividend; and should

apply to the commissioners to appoint a meeting for that purpose, or they may be summoned by them, to shew cause why they have not done so.

Allowance to the bankrupt. Every bankrept surrendering, and in all things conforming to the directions of the act, shall be allowed five per cent. out of the net produce of his estate, provided, after such allowance, it be sufficient to pay his creditors ten shillings in the pound, and that the said five per cent. shall not in the whole exceed 200*l.* Should his estate in like manner pay twelve shillings and sixpence in the pound, he shall be allowed seven and an half per cent. so as not to exceed 250*l.* and if his estate pay fifteen shillings in the pound, he shall be allowed ten per cent. so as not to exceed 300*l.* But the bankrupt is not entitled to such allowance, till after a second dividend; nor can he be entitled to it till he has received his certificate.

Of the surplus. The commissioners are, on request of a bankrupt, to give a true and particular account of the application and disposal of his estate, and to pay the overplus, if any, to the bankrupt.

Of superseding commissions. Commissions may be superseded, for the want of a sufficient debt of the petitioning creditor; or because he was an infant; or for want of sufficient evidence of the trading, or act of bankruptcy; or in cases of fraud; or by agreement or consent of the creditors.

Joint commissions. Partners are liable to a joint commission, or individually, against each; but a joint and separate commission cannot, in point of law, be concurrent. A joint commission must include all partners; if there be three partners, and one of them an infant, there can neither be a commission against the three, nor against the other two.

Felony of bankrupts. If any person, who shall be duly declared a bankrupt, refuse, within 42 days after notice left at his place of abode, and in the London Gazette, to surrender himself to the commissioners, and to fully disclose and discover all his estate and effects, real and personal, and all transferrences thereof, and also all books, papers, and writings, relating thereto, and deliver up to the said commissioners, all such estate and effects, books, papers, &c. as are in his power; (except his necessary wearing apparel, &c.) or in case he shall conceal, or embezzle any part of his estate, real or personal, to the value of 20*l.* or any books of accounts, papers, or writings relating thereto, with intent to defraud his creditors, being lawfully convicted thereof, by judgment or information, shall be adjudged guilty of felony, without benefit of clergy, and his goods divided amongst his creditors.

BANKSIA, in botany, so called in honour of Sir Joseph Banks, who first discovered it in his voyage with Captain Cook; a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Proteæ, Jussieu. Essential character, calyx four cleft, inferior; corolla four-parted; tube very short; border very long, linear, lanceolate: anthers sessile in the cavity of the parts of the corolla; capsule two-seeded, one (or two) celled, two valved. There are eight species. This genus is nearly allied to Protea and Embothrium in appearance and character, but is sufficiently distinguished from both in the fruit. It boasts some of the most specious plants that have been discovered in the South seas, and even in the known word. Those with solitary flowers and one-celled capsules form a separate genus, which Dr. Smith names Salisburia. Some of the species have flowered and seeded here; they have not yet been increased any other way but by seeds. These, and the plants in general from the South Seas, are hardy, considering their climate, and may be treated pretty much in the same manner with the Cape plants. They covet abundance of air, and flourish best near the front of the dry stove.

BANN, in military affairs, a proclamation made in the army, by beat of drum, sound of trumpet, &c. requiring the strict observance of discipline, either for the declaring a new officer, or punishing an offender.

Bann *of the empire*, an imperial proscription, being a judicial punishment, wherewith such as are accessary to disturbing the public peace, are judged unworthy of the immunities and protection of the empire, and are out-lawed or banished, &c.

BANNER denotes either a square flag, or the principal standard belonging to a prince.

BANNERET, an ancient order of knights, or feudal lords, who possessing several large fees, led their vassals to battle under their own flag, when summoned thereto by the king.

This order is certainly most honourable, as it never was conferred but upon some heroic action performed in the field. Anciently, there being but two kinds of knights, great and little, the first were call-

ed bannerets, the second bachelors; the first composed the upper, the second the middle nobility.

The form of the banneret's creation is this; on a day of battle, the candidate presented his flag to the king, or general, who, cutting off the train, or skirt thereof, and making it a square, returned it again; the proper banner of bannerets, who, from hence, are sometimes called knights of the square flag.

The late Sir William Erskine, on his return from the continent in 1764, was made a knight banneret, in Hyde Park, by his present Majesty, in consequence of his distinguished conduct at the battle of Emsdorf. But he was not acknowledged as such in this country, because the ceremony did not take place where the engagement happened. Captain Trollope, of the royal navy, is the last created knight banneret.

BANNISTERIA, in botany, a distinct genus of plants, according to Linnæus; but accounted only a species of Clematis by other botanists.

It belongs to the Decandria Trigynia class; its flower consists of five very large, orbicular petals; and its fruit is composed of three unilocular capsules, running into long alæ.

BANTAM *work*, a kind of painted or carved work, resembling that of Japan, only more gaudy.

Bantam work is of less value among connoisseurs, though sometimes preferred, by the unskilful, to the true Japan work. Formerly it was in more use and esteem than at present, and the imitation of it much practised by our japanners.

There are two sorts of Bantam, as well as of Japan work; as, in the latter, some are flat, lying even with the black, and others high or embossed, so, in Bantam work, some is flat, and others in-cut, or carved into the wood, as we find in many large screens; with this difference, that the Japan artists work chiefly in gold and other metals, and the Bantam generally in colours, with a small sprinkling of gold here and there.

BAPTISM, in matters of religion, the ceremony of washing, by which a person is initiated into the christian church.

Baptism, in the sea-language, a ceremony in long voyages on board merchant ships, practised both on persons and vessels, who pass the tropic or line, for the first time. The baptizing the vessels is simple, and consists only in washing them throughout with sea-water; that of the passengers is more mysterious. The oldest of the crew, that has past the tropic or line, comes with his face blacked, a grotesque cap on his head, and some sea-book in his hand, followed by the rest of the seamen dressed like himself, each having some kitchen utensil in his hand, with drums beating. He places himself on a seat on the deck, at the foot of the mainmast. At the tribunal of this mock magistrate, each passenger not yet initiated swears he will take care the same ceremony be observed, whenever he is in the like circumstances: then by giving a little money by way of gratification, he is discharged with a little sprinkling of water, otherwise he is heartily drenched with streams of water, poured upon him; and the ship-boys are inclosed in a cage, and ducked at discretion. The seamen, on the baptizing a ship, pretend to a right of cutting off the break-head, unless redeemed by the captain.

BAPTISTS, or Antipædobaptists, in church history, a considerable sect who are distinguished from other Christians by their opinions respecting baptism; and who maintain that the ordinance must be administered by the immersion of adults, and not by the sprinkling of infants. Such they say is the meaning of the word βαπτιζω: they call to their aid a variety of passages of scripture, none of which are however so decisive as to put the controversy to rest. And though it is certain that adults were baptized in the earliest periods of the christian system, there is no proof that infants were not admitted to the ordinance. It is not for us to enter into this controversy, which has been cut short by some other Christians, who maintain that baptism was intended only for the converts to the Christian faith, and was not to be repeated upon the children of believers. Hence many persons in the present day do not think it necessary to baptize their children, nor advise them to submit to it when they have attained to years of maturity. As the ordinance, when conducted with solemnity and liberality, is truly impressive, and as it does not occur to every one to witness such a scene during their lives, we shall extract an account of one performed in the neighbourhood of Cambridge, and which has been well described by the late excellent Mr. Robinson, whose name will live, when the distinction of sects and parties shall be obliterated from the Christian church, and when the only profession of faith will be

that in the divine mission of the founder; happy day, when no man shall be excluded from the right-hand of fellowship, because he cannot believe in dogmas of self-created censors, and who cannot join in the ceremonies, for which there is no direct sanction in the New Testament.

"Not many years ago at Whittlesford, seven miles from Cambridge, forty-eight persons were baptized in that ford of the river from which the village takes its name. At ten o'clock, of a very fine morning in May, about 1500 people of different ranks assembled together. At half past ten in the forenoon, the late Dr. Andrew Gifford, Fellow of the Society of Antiquaries, Sub-librarian of the British Museum, and Teacher of a Baptist Congregation in Eagle-street, London, ascended a moveable pulpit, in a large open court-yard, near the river, and adjoining to the house of the lord of the manor. Round him stood the congregation; people on horseback, in coaches, and in carts, formed the outside semicircle; many other persons sitting in the rooms of the house, the sashes being open, all were uncovered, and there was a profound silence. The doctor first gave out a hymn, which the congregation sung. Then he prayed. Prayer ended, he took out a New Testament, and read his text. 'I indeed baptize you with water unto repentance'. He observed, that the force of the preposition had escaped the notice of the translators, and that the true reading was—'I indeed baptize, or dip you in water at, or upon repentance;' which sense he confirmed by the 41st verse of the 12th of Matthew, and other passages. Then he spoke as most Baptists do on these occasions, concerning the nature, subject, mode, and end of this ordinance. He closed by contrasting the doctrine of infant sprinkling, with that of believers' baptism, which being a part of Christian obedience, was supported by divine promises, on the accomplishment of which all good men might depend. After sermon, he read another hymn, and prayed, and then came down. Then the candidates for baptism retired to prepare themselves. About half an hour after, the administrator, who that day was a nephew of the doctor's, and admirably qualified for the work, in a long black gown of fine baize, without a hat, with a small New Testament in his hand, came down to the river side, accompanied by several Baptist ministers and deacons of their churches, and the persons to be baptized. The men came first, two and two, without hats, and dressed as usual, except, that, instead of coats, each had on a long white baize gown, tied round the waist with a sash. Such as had no hair wore white cotton or linen caps. The women followed the men, two and two, all dressed neat, clean, and plain, and their gowns white linen or dimity. It was said, the garments had knobs of lead at the bottom to make them sink. Each had a long light silk cloak hanging loosely over her shoulder, a broad ribband tied over her gown beneath the breast, and a hat on her head. They all ranged themselves around the administrator at the water side. A great number of spectators stood on the bank of the river on both sides; some had climbed and sat on the trees; many sat on horseback and in carriages, and all behaved with a decent seriousness, which did honour to the good sense and the good manners of the assembly, as well as to the free constitution of this country. First the administrator read an hymn, which the people sung; then he read that portion of scripture which is read in the Greek church on the same occasion, the history of the baptism of the eunuch, beginning at the 23d verse, and ending with the 39th. About ten minutes he stood expounding the verses, and then taking one of the men by the hand, he led him into the water, saying as he went, 'see here is water, what doth hinder? If thou believest with all thine heart, thou mayest be baptized.' When he came to a sufficient depth, he stopped, and with the utmost composure, placing himself on the left hand of the man, his face being towards the man's shoulder, he put his right hand between his shoulders behind, gathering into it a little of the gown for hold: the fingers of the left hand he thrusted under the sash before, and the man putting his two thumbs into that hand, he locked all together by closing his hand. Then he deliberately said, 'I baptize thee in the name of the Father, and of the Son, and of the Holy Ghost:' and while he uttered these words, standing wide, he gently leaned him backward and dipped him once. As soon as he had raised him, a person in a boat fastened there for the purpose, took hold of the man's hand, wiped his face with a napkin, and led him a few steps to another attendant, who then gave his arm, walked with him to the house, and assisted him to dress. There were many such in waiting, who like the primitive susceptors, assisted during the whole service. The rest of the

men followed the first, and were baptized in like manner. After them, the women were baptized. A female friend took off at the water side the hat and cloak. A deacon of the church led one to the administrator, and another from him; and a woman at the water side took each as she came out of the river, and conducted her to the apartment in the house, where they dressed themselves. When all were baptised, the administrator coming up out of the river, and standing at the side, gave a short exhortation on the honour and the pleasure of obedience to divine commands, and then with the usual benediction dismissed the assembly. About half an hour after, the men newly baptised having dressed themselves, went from their room into a large hall in the house, where they were presently joined by the women, who came from their apartments to the same place. Then they sent a messenger to the administrator, who was dressing in his apartment, to inform him they waited for him. He presently came, and first prayed for a few minutes, and then closed the whole by a short discourse on the blessings of civil and religious liberty, the sufficiency of scripture, the pleasures of a good conscience, the importance of a holy life, and the prospect of a blessed immortality. This they call a public baptism."

The Baptists in England form one of the three denominations of Protestant dissenters, and are divided into Particular and General, the former are Calvinistical and Trinitarians; the latter are Arminians, and some very few Arians, but the greater part are Unitarians with regard to the person of Christ, considering him as man, the son of Joseph and Mary.

BAR, in courts of justice, an inclosure made with a strong partition of timber, where the council are placed to plead causes. It is also applied to the benches, where the lawyers or advocates are seated, because anciently there was a bar to separate the pleaders from the attornies and others. Hence our lawyers, who are called to the bar, or licensed to plead, are termed barristers, an appellation equivalent to licentiate in other countries.

Bar, in law, a plea of a defendant, which is said to be sufficient to destroy the plaintiff's action. It is divided into bar special, bar to common intendment, bar temporal, and bar perpetual. Bar special, falls out upon some special circumstances of the case in question, as where an executor being sued for his testator's debt, pleads that he had no goods in his hands at the day on which the writ was sued out. Bar to common intendment, is a general bar, which commonly disables the plaintiff's declaration. Bar temporary is such as is good for the present, but may afterwards fail; and bar perpetual is that which overthrows the plaintiff's action for ever. In personal actions, once barred, and ever so, is the general rule, but it is intended, where a bar is to the right of the cause, not where a wrong action is brought. In criminal cases, there are especially four pleas in bar, which go to the merits of the indictment, and give reason why the prisoner ought not to answer it, nor be tried upon it, as a former acquittal, a former conviction, although no judgment were given, a former attainder and a pardon.

Bar, in heraldry, an ordinary in form of the fesse, but much less.

It differs from the fesse only in its narrowness, and in this, that the bar may be placed in any part of the field, whereas the fesse is confined to a single place.

Bar, in music, a stroke drawn perpendicularly across the lines of a piece of music, including between each two a certain quantity or measure of time, which is various as the time of the music is either triple or common. In common time, between each two bars is included the measure of four crotchets; in triple, three. The principal use of bars is to regulate the beating of time in a concert.

Bar, *double*, consists of two parallel straight lines, somewhat broader than a common bar, drawn near each other, and passing perpendicularly through the stave. The double bar divides the different strains of a movement. If two or more dots are placed on one of its sides, they imply that the strain of the movement or the same side with the dots is to be performed twice, and if the dots are placed on each side of the double bar, the repetition extends to the strains on each side of the double bar.

Bar, in hydrography, denotes a bank of sand, or other matter, whereby the mouth of a river is in a manner choked up.

The term bar is also used for a strong beam, wherewith the entrance of an harbour is secured: this is more commonly called boom.

BARALIPTON, among logicians, a term denoting the first indirect mode of the first figure of syllogism. A syllogism in baralipton, is when the two first propositions are

general, and the third particular, the middle term being the subject in the first proposition, and the predicate in the second. Thus,

BA Every evil ought to be feared:
RA Every violent passion is an evil;
LIP Therefore something that ought to be feared is a violent passion.

BARBA, in botany, *a beard*, a species of down with which the surface of some plants is covered. The term was invented by Linnæus, without precise explanation; it seems however to signify a tuft of hairs terminating the leaves.

BARBACAN, or BARBICAN, an outer defence, or fortification to a city or castle, used especially as a fence to the city, or walls; also, an aperture made in the walls of a fortress, to fire through upon the enemy. It is also used as a watch-tower to descry the approach of the enemy; and it sometimes denotes a fort at the entrance of a bridge, or the outlet of a city having a double wall with towers.

BARBACENIA, in botany, a genus of the Hexandria Monogynia class and order. Calyx superior; six-toothed; corol six-petalled; filaments petal-shaped, toothed; capsule glandular, three-valved, many-seeded. Only one species, found at Brazil.

BARBADOES *tar*, a mineral fluid of the nature of the thicker fluid bitumens, of a nauseous, bitterish taste, very strong and disagreeable smell, found in many parts of America trickling down the sides of the mountains, and sometimes floating on the surface of the waters. It has been greatly recommended in coughs, and other disorders of the breast and lungs.

BARBARA, among logicians, the first mode of the first figure of syllogisms.

A syllogism in barbara, is one whereof all the propositions are universal and affirmative; the middle term being the subject of the first proposition, and attributed in the second. For example,

BAR Every wicked man is miserable;
BA All tyrants are wicked men;
RA Therefore all tyrants are miserable.

BARBE, in the military art: to fire in barbe, means to fire the cannon over the parapet, instead of firing through the embrasures; in which case the parapet must not be above three feet and a half high.

BARBED *and crested*, in heraldry, an appellation given to the combs and gills of a cock, when particularized for being of a different tincture from the body.

A barbed cross, is a cross the extremities of which are like the barbed irons used for striking of fish.

BARBEL. See CYPRINUS.

BARBER, one who makes a trade of shaving the beards and heads of men, and of making wigs, &c. Formerly the business of a surgeon was united to that of a barber, and he was denominated a barber-surgeon. This union of profession was dissolved by a statute of Henry VIII. by which the surgeons were formed into a distinct corporation, that existed till the late establishment of "The Royal College of Surgeons of London." In England a musical instrument was part of the furniture of a barber-surgeon's shop, which was used by persons above the ordinary level of life, who resorted thither for the cure of wounds, for bleeding, or trimming, a word that signified shaving, and cutting, or curling the hair. Bleeding and tooth-drawing are now very commonly practised in country places by barbers, and the pole stuck out as the sign of their profession, is supposed to indicate the staff which is held in the patient's hand during the act of bleeding, and the fillet with which it is wound, is tied up after the operation is completed.

BARBERRY, in botany. See BERBERIS.

BARD, a poet among the ancient Gauls and Britons, who celebrated the praises of heroes, with a view to inculcate virtue, and sometimes to terminate a difference between two armies at the point of engagement. It is disputed in what the bards differed from the Druids; some pretend that these were the priests and philosophers of the nation, and that those were only the poets and historians; but it is more probable that Druid was a general word, comprehending the priests, the judges, the instructors of youth, and the bards or poets. See DRUID.

The bards were not only the poets but the genealogists, biographers, and historians of those countries and ages. The genealogical sonnets of the Irish bards are still the chief foundations of the ancient history of Ireland. It was customary for the bards to sing these compositions in the presence of their nobles, and at their chief festivals and solemnities. In the Highlands of Scotland there are bards still in being, and considerable remains of many of the compositions of the old British bards still preserved; but the most genuine, entire, and valuable remains of the works of the ancient bards, and perhaps the noblest specimen of unculti-

vated genius, if not the most sublime fragments of ancient poetry now extant, are the poems of Ossian the son of Fingal, a king of the Highlands, who flourished in the second or third century, lately collected by Mr. Mac-Pherson, and by him translated from the Erse or Gaelic language into English.

The reputation, influence, and power of this order of men were formerly very high, they were courted by the great, and seated at the tables of princes. Their power in exciting the courage and rousing the fury of armies is universally recorded, and generals have often confessed themselves indebted for victory to their heroic strains. They were not unfrequently chosen negotiators with the enemy, and the deeds of the day were in the evening recorded in their songs; and the fame of their fallen heroes perpetuated by their praise.

BARGAIN, in commerce, a contract or agreement in buying and selling. Hence, to buy a good bargain is to buy cheap.

Bargain is also an agreement to give a certain price; and there are three things requisite to make it complete and perfect. 1. The merchandise sold. 2. The price. 3. The mutual agreement or consent.

The merchandise sold ought to be certain, the price of the thing sold should be paid in current money, otherwise it would be an exchange; and the consent ought to be equally free, on both sides, from error and violence. If then there happens to be an error in the substance of the thing bought, it makes the bargain void; but if it lies only in the quality of the thing sold, it does not dissolve the bargain, provided there be no voluntary fraud on the side of the seller. Thus, if I design to buy pewter, and instead of that, the person sells me lead, the sale cannot stand good, because I was imposed upon in the very substance of the thing I wanted to buy. But if I designed to buy a clock that went true, and it does not prove so, the bargain ought to stand, because I was deceived in the qualities only of the thing sold to me.

A bargain and sale of lands, &c. in fee, must, according to our law, be in writing, indented, and enrolled either in one of the courts at Westminster, or in the county where the lands lie, before the custos rotulorum, and justices of peace. A warrant and covenant may be inserted in a bargain and sale, but the deed is good without any such addition; and if it be made for money and natural affection, the estate will pass, though you do not enrol it.

BARGE, in naval affairs, a boat of state and pleasure, adorned with various ornaments, having bales and tilts, and seats covered with cushions and carpets, and benches for many oars; as a company's barge, an admiral's barge, &c. It is also the name of a flat-bottomed vessel employed for carrying goods in a navigable river, as those upon the river Thames, called west country barges.

BARILLA, in the arts, is an alkaline substance, prepared principally in Spain and Italy from sea-plants, which are there cultivated for the purpose. The discovery of the use of these plants was made by the Saracens in Spain, who called the particular plant from which they extracted it kali, which, with the addition of the Arabian article *al*, gave rise to the term alkali. The barilla is obtained by cutting down the plant when it has attained its full height, and drying it; after which it is burnt, and during the operation the ashes harden into lumps or cakes. This country is supplied with barilla, chiefly from Spain, the island of Teneriffe, and Sicily. It is used by glass-makers, soap-boilers, bleachers, and in other manufactures.

BARK, in vegetable anatomy, a term which denotes the exterior part of vegetable bodies; which is separable from the other parts of the plant, during the season of vegetation, but at other times requires maceration in water, or boiling; and when detached by any of these means, the fine connections which unite it to the wood are destroyed. When bark is thus separated, and seen by means of the microscope, it exhibits parts differing much in structure and use. These have been divided into the cuticle or epidermis; the cellular envelope or parenchyma, and the cortical layer and liber. The epidermis is a thin transparent membrane, which covers all the outside of the bark. It is pretty tough. When inspected with a microscope, it appears to be composed of a number of slender fibres crossing each other, and forming a kind of net-work. It seems even to consist of different thin retiform membranes, adhering closely together. This, at least, is the case with the epidermis of the birch, which Mr. Duhamel separated into six layers. The epidermes, when rubbed off, is reproduced. In old trees it cracks and decays, and new epidermis are successively formed. This is the reason that the trunks of many old trees have a rough surface. The parenchyma lies immediately below the epidermis; it is

of a deep green colour, very tender and succulent. When viewed with a microscope, it seems to be composed of fibres which cross each other in every direction, like the fibres which compose a net. Both in it and the epidermis there are numberless interstices, which have been compared to so many small bladders. The cortical layers form the innermost part of the bark, or that which is next to the wood. They consist of several thin membranes, lying the one above the other; and their number appears to increase with the age of the plant. Each of these layers is composed of longitudinal fibres, which separate and approach each other alternately, so as to form a kind of net-work. The meshes of this net-work correspond in each of the layers; and they become smaller and smaller in every layer as it approaches the wood. These meshes are filled with a green-coloured cellular substance, which has been compared by anatomists to a number of bladders adhering together, and communicating with each other.

The matter of the parenchyma, and the juices which exist in barks, vary extremely, and probably occasion most of the differences between them. Some, as oak bark, are characterized by their astringency, and contain tannin; others, as cinnamon, are aromatic, and contain an essential oil; others are bitter, as Jesuits bark; some are chiefly mucilaginous, others resinous, &c.

1. Bark of the cinchona floribunda, or quinquina of St. Domingo. This bark is in rolled pieces, six or seven inches long, and three or four lines in thickness. Its colour is greyish green externally, but within it exhibits different shades of green, purple, white, brown, &c. Its taste is bitter and disagreeable; its odour strong and unpleasant. It gives out nearly half its weight to water, provided it be boiled in a sufficient quantity of that liquid. The residue possesses the properties of woody fibre. The decoction of the bark has a reddish brown colour, and an extremely bitter taste. It deposits on cooling a blackish substance, soft and tenacious, which does not dissolve in cold water, though it is soluble in hot water and in alcohol. More of this substance precipitates as the liquor is evaporated. When the inspissated juice, freed from this precipitate, is mixed with alcohol, a quantity of gummy matter separates. When the black matter which precipitates as the decoction cools, is treated with hot alcohol, the greatest part of it is dissolved; but a fine red powder remains mixed with some mucilage, which is easily separated by water. When the alcoholic solution is exposed to the air, it deposits light yellowish crystals of a saline nature. When mixed with water, white flakes are thrown down, which possess the properties of gluten; but the greatest part remains in solution. Thus the soluble part of the bark may be separated into five distinct substances; namely, gum, gluten, a red powder, a saline matter, and a brownish bitter substance, retained in solution by the diluted alcohol. The last is by far the most abundant. To it the peculiar qualities of the decoction of this bark are to be ascribed.

2. Bark of cinchona officinalis. This tree grows in Quito; it is confined to the high grounds, and when stripped of its bark soon dies. There are three different kinds of bark to be found in commerce, but whether they be all obtained from the same trees is not known; the contrary is probable. The following are the most remarkable of these varieties. Red Peruvian bark.—This bark is usually in large pieces, and is reducible to powder with more ease than the preceding. Its powder is reddish brown, and has a slightly bitter taste, with a good deal of astringency. Yellow Peruvian bark.—This species of bark, first brought into use in this country about the year 1790, has not yet been subjected to a rigorous analysis; but its constituents do not appear, from the trials which have been made, to differ much from those of the red species. Pale Peruvian bark.—This is the common variety of the bark. It has not yet been subjected to a correct chemical analysis. Its taste is astringent and bitter, and very disagreeable. It is supposed to contain a bitter principle, tannin, extractive, and resin. Besides these, it contains a principle first pointed out by Seguin, and upon which Dr. Duncan, junior, published some experiments. It is distinguished by the property of precipitating infusion of galls; but as this property is common to a considerable number of substances, it is not sufficient alone to characterize it.

3. Bark of cinchona caribæa.—This bark was first made known by Dr. Wright, who published a botanical description of the tree, with a figure, in the Philosophical Transactions, vol. 67, and an account of the medicinal properties of the bark in the London Medical Journal for 1787. A description of a tree to which the same name is given,

together with a chemical analysis of the bark, was published in the Journal de Physique for 1790, by M. Vavasseur; but it is not quite certain that the plants are the same.

4. Bark of the white willow (salix alba.)—The bark of this three, which is common enough in Scotland, is remarkable for its astringent taste, and has been often used in intermittents by the common people. It has lately been proposed by Bouillon la Grange as an excellent substitute for Peruvian bark; being composed, according to him, of the very same constituents to which that bark owes its medical virtues. A very superficial examination, however, may satisfy any one, that the properties of the two are very far from similar.

5. Bark of quercus nigra.—This tree, to which the name of quercitron has been given, grows spontaneously in North America. Dr. Bancroft discovered, about the year 1784, that the inner bark of this tree contains a great quantity of colouring matter; and since that time, it has been very generally used by the dyers. To prepare it for them, the epidermis (which contains a brown colouring matter) is shaved off, and then the bark is ground in a mill. It separates partly into stringy filaments, and partly into a fine light powder.

Bark, or *Jesuit's bark*, is a name given by way of eminence to the cinchona. See Materia Medica and Pharmacy.

Bark, in navigation, a little vessel with two or three triangular sails; but according to Guillet, it is a vessel with three masts, *viz.* a main-mast, fore-mast, and mizen-mast. It carries about two hundred tons.

BARKING *of trees*, the peeling off the rind or bark, which must be done, in our climate, in the month of May, because at that time the sap of the tree separates the bark from the wood. It would be very difficult to perform it at any other time of the year, unless the season was extremely wet and rainy, for heat and driness are a very great hinderance to it.

BARLERIA, in botany, so named in honour of James Barrelier, a Dominican, whose Icones were published in 1714, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Acanthi, Jussieu. Essential character: calyx four-parted; stamens two far less than the others; capsule quadrangular, bilocular, bivalval, elastic; without the claws; seeds two. There are eleven species, and being all natives either of the East Indies or South America, require the protection of the bark-stove.

BARLEY, in botany. The principal use of barley in this country is for making beer; but, in seasons like the present, when peas are very scarce, large quantities of it are used in feeding hogs. In Scotland barley is a common ingredient for broths; it is also much used for the same purpose in England at the tables of persons of rank. In some parts of the continent horses are fed with barley. Pearl barley, and French barley, are barley freed from the husk by means of a mill, the distinction between the two being, that pearl barley is reduced to the size of very small shot, all but the heart of the grain being ground away. See Hordeum.

Barley, in chemistry, is the seed of the hordeum vulgare, which will be described hereafter. Great crops of it are reared annually, partly as an article of food, and partly as a material from which malt liquors and ardent spirits are drawn. This species of corn has been examined of late with considerable attention by chemists, partly in order to form correct conceptions, if possible, of the nature of the process of fermentation, and partly to ascertain the constituents of barley. Fourcroy and Vauquelin published several ingenious remarks and experiments on it in 1806, and Einhof published a still more elaborate analysis about the commencement of the same year; having examined this grain in different stages of its growth, and after it was fully ripe. When unripe barley-corns are triturated with water, the liquid acquires a milky colour. If this process be continued, adding fresh portions of water as long as the liquid passes off muddy, there remains only a green husky matter. When this matter is macerated a sufficient time in cold water, it acquires a greenish grey colour, and when dry has the appearance of vegetable fibre. The water in which it was macerated, when boiled, deposits a few flakes of albumen, and when evaporated to dryness leaves a small portion of extractive. The water with which the barley was at first triturated is at first milky, and gradually deposits a white powder; yet it does not become transparent, though allowed to stand a considerable time. When filtered, it passes through transparent, while a slimy substance of a greenish grey colour remains upon the filter. This substance possesses the properties of gluten. When the solution, now transparent, and of a yellowish colour, is boiled, it

deposits flakes of albumen. It reddens litmus paper, and is strongly precipitated by lime-water, nitrate of lead, and sulphate of iron, indicating the presence of phosphoric salts. The liquid being evaporated to the consistence of a syrup, and the residue treated with alcohol, the solution diluted with water, and the alcohol distilled off, to separate some gluten which still remained, a syrupy matter was obtained, having a sweet taste, which was considered as the saccharine matter of the barley. A portion refused to dissolve in alcohol. This portion was considered as extractive. The white powder which precipitated from the water in which the barley had been originally triturated, possessed the properties of starch.

Barley-*corn*, the least of our long measures, being the third of an inch.

BARLOWE (William) in biography, an eminent mathematician and divine, was born in Pembrokeshire, his father (William Barlowe) being then bishop of St. David's. In 1560 he was entered commoner of Baliol College in Oxford; and in 1564, having taken a degree in arts, he left the university, and went to sea, where he acquired considerable knowledge in the art of navigation, as his writings afterwards shewed. About the year 1573 he entered into orders, and obtained much and valuable preferment, and at length was appointed chaplain to Prince Henry, eldest son of King James the First; and, in 1614, archdeacon of Salisbury. Barlowe was remarkable, especially for having been the first writer on the nature and properties of the loadstone, 20 years before Gilbert published his book on that subject. He was the first who made the inclinatory instrument transparent, and to be used with a glass on both sides. It was he also who suspended it in a compass-box, where, with two ounces weight, it was made fit for use at sea. He also found out the difference between iron and steel, and their tempers for magnetical uses. He likewise discovered the proper way of touching magnetical needles; and of piecing and cementing of loadstones; and also why a loadstone, being double-capped, must take up so great a weight. He died in the year 1625. His works are numerous and respectable.

BARM, otherwise called *Yeast*, the head or workings out of ale or beer.

RARNACLE, in ornithology, a species of goose with a black beak, which is much shorter than in the common goose. See Anas.

Barnacle is also a species of shell-fish, otherwise called concha anatifera. See the article Concha.

Barnacles, in farriery, an instrument composed of two branches joined at one end with a hinge, to put upon horses' noses when they will not stand quietly to be shod, blooded, or dressed.

BARNADESIA, in botany, so called from Michael Barnades, a Spanish botanist, a genus of the Synegenesia Polygamia Æqualis class and order: natural order of Compositæ Discoidæ; Corymbiferæ, Juss. Essential character: calyx naked, imbricate, pungent; corolla radiate. Down of the ray feathered; of the disk, bristly, broken backwards. There is only one species, B. spinosa, a shrub with very smooth branches, set with a pair of thorns at their origin, which at first were stipules; they are patulous, brown, and smooth. It is a native of South America.

BAROCO, in logic, a term given to the fourth mode of the second figure of syllogisms. A syllogism in baroco has the first proposition universal and affirmative, but the second and third particular and negative, and the middle term is the predicate in the two first propositions. For example:

Nullus homo non est bipes:
Non omne animal est bipes:
Non omne animal est homo.

BAROMETER, an instrument for measuring the weight or pressure of the atmosphere; and by that means the variations in the state of the air, foretelling the changes in the weather, and measuring heights or depths, &c. About the beginning of the 17th century, when the doctrine of a plenum was in vogue, it was a common opinion among philosophers, that the ascent of water in pumps was owing to what they called nature's abhorrence of a vacuum; and that thus fluids might be raised by suction to any height whatever. But an accident having discovered that water could not be raised in a pump unless the sucker reached to within 33 feet of the water in the well, it was conjectured by Galileo, who flourished about that time, that there might be some other cause of the ascent of water in pumps, or at least that this abhorrence was limited to the finite height of 33 feet. Being unable to satisfy himself on this head, he recommended the consideration of the difficulty to Torricelli, who had been his disciple. After some time Torricelli fell upon the suspicion, that the pressure of the atmos-

phere was the cause of the ascent of water in pumps; that a column of water 33 feet high was a just counterpoise to a column of air of the same base, and which extended up to the top of the atmosphere; and that this was the true reason why the water did not follow the sucker any farther. And this suspicion was soon after confirmed by various experiments. See ATMOSPHERE.

It was some time, however, before it was known that the pressure of the air was various at different times in the same place. This could not, however, remain long unknown, as the frequent measuring of the column of mercury must soon shew its variations in altitude; and experience and observation would presently shew that those variations in the mercurial column were always succeeded by certain changes in the weather, as to rain, wind, frosts, &c.: hence this instrument soon came into use as the means of foretelling the changes of the weather, and on this account it obtained the name of the weather-glass, as it did that of barometer from its being the measurer of the weight or pressure of the air. We may now proceed to take a view of its various forms and uses.

The common mercurial barometer, (plate Miscel. fig. 9.) or weather-glass, is a cylindrical glass tube, whose diameter is generally about $\frac{1}{3}$d or $\frac{1}{4}$th of an inch in diameter, and length 34 inches, filled with prepared mercury; one end of the tube, A, is hermetically sealed, and the open end, B, inserted into a bason of mercury. The tube and bason are fixed to a frame of wood, and suspended in a vertical situation. The height of the mercury in the tube above the surface of the mercury in the bason is called the standard altitude, and the difference between the greatest and least altitudes is called the limit or scale of variation.

The mercury in the barometer tube will subside, till the column be equivalent to the weight of the external air upon the surface of the mercury in the bason, and it is therefore a criterion to measure that weight, and chiefly directed to that purpose. In this kingdom the standard altitude fluctuates between 28 and 31 inches; and from hence it is justly inferred, that the greatest, least, and intermediate weights of the atmosphere upon a given base are respectively equal to the weights of columns of mercury upon the same base, whose vertical altitudes are 28, 31 inches, and some altitude contained between them.

The standard altitude ought to be the same, whatever be the diameter of the barometer tube; but when this diameter is very small, the attraction of cohesion between the mercury and glass prevents a variation of altitude, which ought to be, and in larger tubes is, sensible from small differences in the weight of the atmosphere.

Writers on this subject have given the following lemma:—If a given line, L, be divided into n equal parts, and $L \times \frac{n+m}{n}$ be also divided into n equal parts, each division of L will be less than that of $L \times \frac{m+m}{n}$ by $L \times \frac{m}{n^2}$.

When L is divided into n equal parts, each part is equal to $L \times \frac{1}{n}$, or $L \times \frac{n}{n^2}$; and each part of $L \times \frac{n+m}{n}$, thus divided, is equal to $L \times \frac{n+m}{n^2}$, which is greater than the former by $L \times \frac{m}{n^2}$.

If each inch of the scale of variation, A D, (fig.10.) of a barometer tube be divided into ten equal parts, marked with 1, 2, 3, &c. increasing upwards, and a vernier or nonius, L M, whose length is $\frac{11}{10}$ths of an inch, be divided into ten equal parts, marked with 1, 2, 3, &c. increasing downwards, and so placed as to slide along the graduated scale of the barometer, the altitude of the mercury in the tube above the surface of that in the bason may be found in inches and hundredth parts of an inch by this process. If the surface of the mercury in the tube do not coincide with a division in the scale of variation, place the index of the vernier, M, even with the surface, and observing where a division of the vernier coincides with one in the scale, the figure in the vernier will shew what hundredth parts of an inch are to be added to the tenths immediately below the index. Let, for instance, the surface of the mercury be between 7 and 8 tenths above 30 inches, and the index of the vernier being placed even with it, and the figure 5 upon the vernier being observed to coincide with a division upon the scale, the altitude of the barometer will be 30 inches and $\frac{5}{100}$ths of an inch: for each division of the vernier being greater than that of the scale by $\frac{1}{100}$th of an inch (lemma,) and there being five divisions, the whole must be $\frac{5}{100}$ths of an inch above the number 7 in the scale, and the height of the mercury is therefore 30.75 inches.

Whatever be the number of divisions in the scale of variation, and in the vernier, the height of the mercury in the barometer is easily discovered by a process similar to that already mentioned.

There are several other kinds of barometers, of which it will be sufficient to give a short description.

1. In the portable barometer, the lower part of the tube is bent upwards, and wider than the rest of the tube; and in this recurvated part the mercury is exposed to the pressure of the atmosphere; or the mercury in the bason is contained in a flexible leathern bag, exposed to the same pressure. In this last, the mercury is forced into the tube so as to fill it, by a screw fixed in the bottom of a wooden box containing the bag, lest the motion of the mercury should break the tube.

2. In the diagonal barometer, (fig. 11) the scale of variation is bent into the direction D R, making an obtuse angle with the vertical part B D. The scale of variation is by this barometer increased in the ratio of D R: D A; but this increase does not compensate for the friction and attraction of cohesion upon the lower side of D R. And when the angle R D A is greater than 45°, the instrument is rendered useless by the separation of globules of mercury from the column.

3. The wheel-barometer, (fig. 12) is a compound tube, S E R B D, open at D and closed at E, the diameter of the highest part, S E R, being much greater than that of the rest, and filled with mercury from D to S R, and above that vacuous. Upon the surface of the mercury in the recurved leg there is an iron ball in equilibrio with another, H, by a string passing over a pully, P. As the ball at D rises and falls with the mercury, the string turns the pulley, and an index, I N, fixed to it, which points to different parts of a graduated circle. It is clear, that by increasing the diameter of the circle, this contrivance will shew the minutest variations of the air, provided the friction be inconsiderable, which is seldom true.

4. The pendent barometer, (fig.13) is composed of a tube of a very small bore, a little conical or tapering, closed at the smaller orifice, A, and filled with prepared mercury from A to B, whose distance is equal to the greatest altitude, or about 31 inches. Let the tube be suspended vertically, and the mercury will subside, and be quiescent in that part whose length is equal to the standard altitude at that time; and supposing that to be the least, it will occupy a space F E equal to 28 inches; and consequently A F is the scale of variation. If A E = 60 inches, then A F = 32, when in the common barometer it is only 3 inches. The diameter of this barometer tube is very small, and consequently the attraction of cohesion considerable, which prevents the freedom of motion necessary to ascertain minute variations of the air's pressure.

5. In the horizontal rectangular barometer, (fig.14) the highest part of the tube, opposite to the scale of variation, is wider than the rest of the tube; and the mercury, descending 3 inches from A to D, will describe a much longer space in the horizontal leg F G, these spaces being to each other inversely as the squares of the diameters of the tubes, and, that of F G being very small, its motion will be extremely sensible. But the free motion of the mercury in F G is impeded by friction, and the attraction of cohesion, which from the smallness of the tube is considerable; and besides this, globules of mercury are apt to be separated from M, and flow out at G.

By the above, and other expedients, as using water, or water and mercury, the scale of variation is enlarged; but the common barometer is the best, being subject to the fewest inconveniences. In the construction and use of it, the following particulars are to be observed. 1. The diameter of the tube should be $\frac{1}{3}$d or $\frac{1}{4}$th of an inch, to prevent the effects of the attraction of cohesion; the length of the tube 33 or 34 inches, with a bulb upon the top, into which the air may be diffused, should any remain in the mercury. 2. The diameter of the cistern containing the mercury should be large (at least ten times greater than that of the tube) that the addition or subtraction of the mercury, contained between the greatest and least altitudes, may not sensibly affect its depth; for the numbers, marked upon the side of the tube, shew their distance from a fixed point, and cannot shew the height of the column above the mercury in the cistern, unless its surface coincide with this point, and be immovable. 3. The mercury should be free from any mixture of other metals, and purged of air by being boiled in a glazed earthen vessel, closely covered, and poured, when hot, through a glass funnel, with a long capillary tube, into the barometer tube washed with a rectified spirit, and cleaned with a piston of shammy

leather, if both ends were not hermetically sealed when it was made, and heated and rendered electrical by rubbing. 4. Unless the temperature of the air remain the same, the dimensions of a given quantity of mercury will be variable, and the altitude of the mercury is an uncertain measure of the weight of the atmosphere, because it is dilated by heat, and contracted by cold, when perhaps the weight of the atmosphere is unaltered. If very great exactness be therefore required, the difference of temperature, at the different times of observation, and the depression or elevation of the mercury produced by it, must be ascertained, before the height of the column, raised by the weight of the atmosphere, can be discovered. See WEATHER, *rules for judging of.*

The barometer applied to the measuring of altitudes.—The secondary character of the barometer, namely as an instrument for measuring accessible heights or depths, was first proposed by Pascal, and Descartes and succeeding philosophers have been at great pains to ascertain the proportion between the fall of the barometer and the height to which it is carried; as Halle, Mariotte, Shuckburgh, Roy, and more especially by De Luc, who has given a critical and historical detail of most of the attempts that have at different times been made for applying the motion of the mercury in the barometer to the measurement of accessible heights. And for this purpose serves the portable barometer already described, which should be made with all the accuracy possible. Various rules have been given by the writers on this subject, for computing the height ascended from the given fall of the mercury in the tube of the barometer, the most accurate of which was that of Dr. Halley, till it was rendered much more accurate by the indefatigable researches of De Luc, by introducing into it the corrections of the columns of mercury and air, on account of heat. This rule is as follows: *viz.* $10000 \times \log.$ of $\frac{M}{m}$ is the altitude in fathoms, in the mean temperature of 31°; and for every degree of the thermometer above that, the result must be increased by so many times its 435th part, and diminished when below it: in which theorem M denotes the length of the column of mercury in the barometer tube at the bottom, and m that at the top of the hill, or other eminence; which lengths may be expressed in any one and the same sort of measures, whether feet, or inches, or tenths, &c. and either English, or French, or of any other nation; but the result is always in fathoms, of 6 English feet each. The following rules must be attended to.

1. Observe the height of the barometer at the bottom of any height or depth, proposed to be measured; together with the temperature of the mercury, by means of the thermometer attached to the barometer, and also the temperature of the air in the shade by another thermometer which is detached from the barometer.

2. Let the same thing be done also at the top of the said height or depth, and as near to the same time with the former as may be. And let those altitudes of mercury be reduced to the same temperature, if it be thought necessary, by correcting either the one or the other, *viz.* augmenting the height of the mercury in the colder temperature, or diminishing that in the warmer, by its 9600th part for every degree of difference between the two; and the altitudes of mercury so corrected, are what are denoted by M and m, in the algebraic formula above.

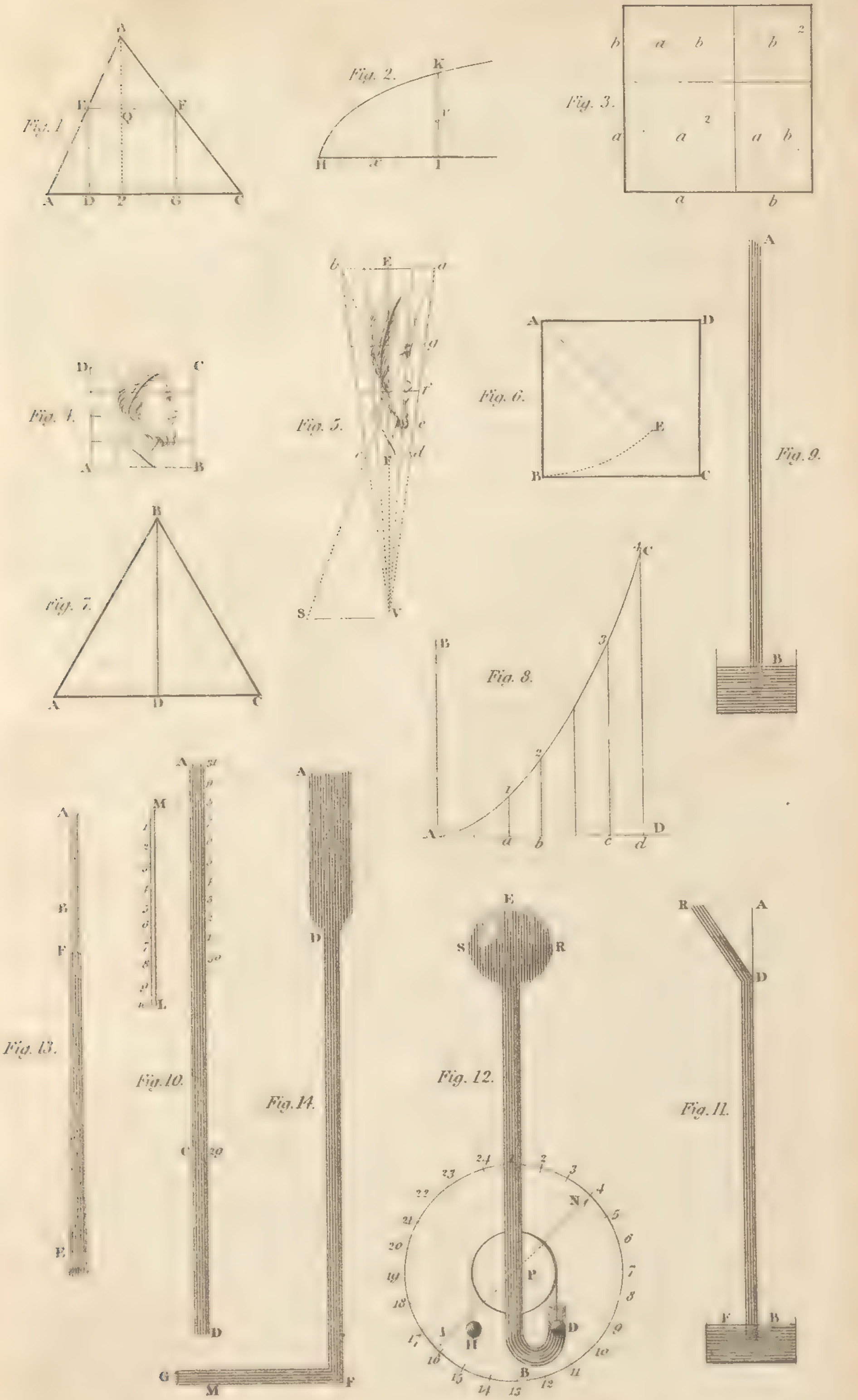
3. Take out the common logarithms of the two heights of mercury, so corrected, and subtract the less from the greater, cutting off from the right hand side of the remainder three places for decimals; so shall those on the left be fathoms in whole numbers, the tables of logarithms being understood to be such as have seven places of decimals.

4. Correct the number last found, for the difference of the temperature of the air, as follows; *viz.* take half the sum of the two temperatures of the air, shewn by the detached thermometers, for the mean one; and for every degree which this differs from the standard temperature of 31°, take so many times the 435th part of the fathoms above found, and add them if the mean temperature be more than 31°, but subtract them if it be below 31°; so shall the sum or difference be the true altitude in fathoms, or being multiplied by 6, it will give the true altitude in English feet.

Ex. 1. Let the state of the barometers and thermometers be as follows, to find the altitude; *viz.*

Thermometers. detached.	Thermometers. attached.	Barometers.
57	57	29.68 lower
42	43	25.28 upper
mean $49\frac{1}{2}$	dif. 14	

MISCELLANIES.



Published Feb.y 1 1808, by Longman, Hurst, Rees, & Orme, Paternoster Row, London.

Cooper sculp.

As 9600 : 14 :: 29.68 : .04
cor. .04 logs.

mean $49\frac{1}{2}$ $M = 29.64$ - 4718782
stand. 31 $m = 25.28$ - 4027771

dif. $18\frac{1}{2}$ As 435 : $18\frac{1}{2}$ :: 691.011 : 29.388
29.388

the altitude sought is { 720.399 fath. or 4322.394 feet.

Ex. 2. To find the altitude of a hill, when the state of the barometer and thermometer, as observed at the bottom and top of it, is as follows; *viz.*

Thermometers. detached.	attached.	Barometers.
35	41	29.45
31	38	26.82
mean 33	dif. 3	

As 9600 : 3 :: 29.45 : .01
.01 logs.

mean 33 $M = 29.44$ - 4689378
stand. 31 $m = 26.82$ - 4284588

dif. 2 As 435 : 2 :: 404.790 : 1.86
1.86

the altitude sought is { 406.65 fathoms. or 2439.93 feet.

The mean height of the barometer in London, upon an average of two observations in every day in the year, kept at the house of the Royal Society for many years past, is 29.88; the medium temperature, or height of the thermometer, according to the same, being 58°. But the medium height at the surface of the sea, according to Sir Geo. Shuckburgh, is 30.04 inches, the heat of the barometer being 55°, and of the air 62°. See PNEUMATICS.

BARON, in British customs, a degree of nobility next to a viscount, but the highest in point of antiquity. In the House of Peers dukes, marquisses, earls, viscounts, and barons, are all equal members, whence they are collectively called a House of Peers, or equals; but, in other respects, they claim and enjoy certain honours and distinctions, peculiar to their respective ranks and the date of their creations. See PRECEDENCE.

The original, by writ, Camden refers to King Henry III. and barons, by letters patent or creation, commenced in the reign of Richard II. to these is added a third kind of barons, called barons by tenure. The chief burgesses of London were in former times barons, before there was a lord-mayor; the earl-palatines had anciently their barons under them; but no barons, except those who held immediately under the king, were peers of the realm.

BARONS *of the exchequer*, the four judges to whom the administration of justice is committed, in causes between the king and his subjects, relating to matters concerning the revenue. They were formerly barons of the realm, but of late are generally persons learned in the laws. Their office is also to look into the accounts of the king, for which reason they have auditors under them.

BARON *and feme*, in our law, a term used for the husband in relation to his wife, who is called feme; and they are deemed but one person, so that a wife cannot be witness for or against her husband, nor he for or against his wife, except in cases of high treason.

BARON *and feme*, in heraldry, is when the coats of arms of a man and his wife are borne per pale in the same escutcheon, the man's being always on the dexter side, and the woman's on the sinister; but here the woman is supposed not an heiress, for then her coat must be borne by the husband on an escutcheon of pretence.

BARONS *of the Cinque-ports*, are sixteen members of the House of Commons, elected by the Cinque-ports; two for each port.

BARONET, a modern degree of honour, next to a baron, created by King James I. in order to propagate a plantation in Ulster, in Ireland, for which purpose each of them was to maintain thirty soldiers in Ireland, for three years, after the rate of eight pence sterling per day to each soldier. The honour is hereditary, and they have the precedence of all knights, except those of the garter, bannerets, and privy-counsellors. They are stiled baronets in all writs, and the addition of Sir is attributed to them, as the title of Lady is to their wives. No honour is to be created between barons and baronets.

BARONETS *of Ireland*, a dignity instituted 30 Sept. 1619.

BARONY, the honour and territory which gives title to a baron, whether he be a layman or a bishop. According to Bracton, a barony is a right indivisible; wherefore, if an inheritance is to be divided among coheirs, though some capital messuages may be divided, yet if the capital messuage be the head of a county or barony, it may not be parcelled; and the reason is, lest by this division many of the rights of counties and baronies by degrees come to nothing, to the

prejudice of the realm, which is said to be composed of counties and baronies.

BARRA, in commerce, a long measure used in Portugal and some parts of Spain, to measure woollen cloths, linen cloths, and serges.

BARRACAN, in commerce, a sort of stuff not diapered, something like camblet, but of a coarser grain. It is used to make cloaks, surtouts, and such other garments to keep off the rain.

BARRACKS, places for soldiers to lodge in, especially in garrisons. Barracks were formerly reckoned as highly dangerous to the constitution of the realm; within these last ten years, however, they have increased so much in number and extent, that there is scarcely a moderate sized town in the kingdom without its barracks; and one might infer from the rapid increase of these buildings, that our very existence depends upon them.

BARRATOR, in law, a common mover or maintainer of suits and quarrels, either in courts or elsewhere in the country. A man cannot be adjudged a barrator for bringing any number of suits in his own right, though they are vexatious. Barrators are punished by fine and imprisonment.

BARRATRY, in law, signifies the fomenting quarrels and law-suits.

BARRATRY, in a ship-master, is his cheating the owners. If goods delivered on shipboard are embezzled, all the mariners ought to contribute to the satisfaction of the party that lost his goods, by the maritime law; and the cause is to be tried in the admiralty. In a case where a ship was insured against the barratry of the master, &c. and the jury found that the ship was lost by the fraud and negligence of the master, the court agreed that the fraud was barratry, though not named in the covenant; but that negligence was not.

BARREL is a measure of liquids. The English barrel, wine measure, contains the eighth part of a tun, the fourth part of a pipe, and one half of an hogshead; that is to say, it contains thirty-one gallons and a half: a barrel, beer-measure, contains thirty-six gallons.

BARREL also denotes a certain weight of several merchandises, which differs according to the several commodities: a barrel of Essex butter weighs one hundred and six pounds, and of Suffolk butter, two hundred and fifty-six pounds. The barrel of herrings ought to contain thirty-two gallons wine-measure, which amount to about twenty-eight gallons old standard, containing about a thousand herrings. The barrel of salmon must contain forty-two gallons. The barrel of eels the same. The barrel of soap must weigh two hundred and fifty-six pounds.

BARREL, *fire*, in military affairs, is mounted on wheels, filled with a composition, and intermixed with loaded grenades, and the outside full of sharp spikes: some are placed under ground to act as mines: others are used to roll down a breach to prevent the enemy's entrance. These are rarely used now in any country.

BARREL, in mechanics, a term given by watch-makers to the cylinder about which the spring is wrapped: and by gun-smiths to the cylindrical tube of a gun, pistol, &c. through which the ball is discharged.

BARRERIA, in botany, named after Peter Barrere, a French physician, a genus of the Syngenesia Monogymia class and order. Essential character; calyx five-toothed, very small; corol five-parted; style short; stigma trifid. There is only one species, *viz.* B. guianensis. This tree rises forty or fifty feet in height, and is two feet and a half in diameter; the bark is ash-coloured, and the wood is reddish brown, hard and compact. It sends forth from the top a great number of branches, which rise and spread in all directions. These branches are loaded with twigs, on which are alternate leaves ending in a point. It is a native of Guiana, and flowers there in November.

BARRICADE, or BARRICADO, a warlike defence, consisting of empty barrels and such like vessels filled with earth, stones, carts, trees cut down, against an enemy's shot, or assault; but generally trees cut with six faces, which are crossed with battoons as long as a half-pike, bound about with iron at the feet.

In a vessel of war, the vacant spaces between the stancheons are commonly filled with rope, mat, cork, or pieces of old cable, and the upper part which contains a double rope netting above the sail, is stuffed full with hammocks, to intercept the motion, and prevent the execution of small shot in the line of battle.

BARRIER, in fortification, a kind of fence made at a passage, retrenchment, &c. to stop up the entry thereof, and is composed of great stakes, about four or five feet high, placed at the distance of eight or ten feet from one another, with transums, or over thwart rafters, to stop either horse

or foot, that would enter or rush in with violence: in the middle is a moveable bar of wood, that opens and shuts at pleasure. A barrier is commonly set up in a void space, between the citadel and the town, in half-moons, &c.

BARRINGTONIA, in botany, so named from the Hon. Daines Barrington, a genus of the Monadelphia Polyandria class and order. Natural order Hesperideæ: Myett, Jussieu. Essential character, calyx simple, two-leaved, superior, permanent; fruit a dry four-cornered drupe, inclosing a nut, one to four-celled. There is but a single species, *viz.* B. speciosa, a lofty tree and the handsomest in the whole equinoctial flora, with its thick, shady bunches of leaves, and its large, handsome, purple, and white flowers, every where mixed with them. The trunk is lofty, thick, straight; covered with a dark grey, smooth bark, scored with little chinks. The branches are round, expand very widely, subflexuose, variously divided, covered with a chinky bark, and leafy at the ends. The flowers are very large, white, and transparent; the filaments are white with a purple top, and diaphanous at the base; the anthers are gold coloured; the style white with a purple top. The flowers open during the night, and fall at sun rise; the birds also pluck them off, and the ground about these trees is perfectly covered with them. The seed mixed with the bait, inebriates fish in the same manner with cocculus indicus. It grows within the Tropics, especially on the shores of the ocean, and at the mouths of rivers in the East Indies, from the southern coasts of China through the Molucca Isles to Otaheite, and the other Society Isles, &c. It is cultivated in the governor's garden at the island of St. Helena.

BARRISTER, in common law, a person qualified and impowered to plead and defend the cause of clients, in the courts of justice. They are of two sorts, the outward, or outer barristers, who, by their long study in, and knowledge of, the law, which must be for a term of seven years at least, are called to public practice, and always plead without the bar. The inner barristers are those who, because they are either attorney, solicitor, serjeant, or counsel to the king, are allowed, out of respect, the privilege of pleading within the bar. But at the Rolls, and some other inferior courts, all barristers are admitted within the bar.

Barristers who constantly attend the King's Bench, are to have the privilege of being sued in transitory actions, in the county of Middlesex. The fees to a counsellor are not given as hire, but as a mere gratuity, which a barrister cannot demand, without injuring his reputation.

BARROW (ISAAC), a very eminent mathematician and divine, was born at London in October, 1630, being the son of Thomas Barrow, then a linen-draper of that city, but descended from an ancient family in Suffolk. He was at first placed at the Charter-house school for two or three years; where his behaviour afforded but little hopes of success in the profession of a scholar. Being removed to Felsted in Essex, his disposition took a different turn; and having soon made great progress in learning, he was first admitted a pensioner of Peter House in Cambridge; but when he came to join the university, in February 1645, he was entered at Trinity College. He now applied himself with great diligence to the study of all parts of literature, especially natural philosophy. He afterwards turned his attention to the profession of physic, and made a considerable progress in anatomy, botany, and chemistry: he next studied divinity; then chronology, astronomy, geometry, and the other branches of the mathematics; with what success, his writings afterwards most eminently shewed.

When Dr. Duport resigned the chair of Greek professor, he recommended his pupil Mr. Barrow for his successor, who, in his probation exercise, shewed himself equal to the character that had been given him by this gentleman; but being suspected of favouring Arminianism, he was not preferred. This disappointment determined him to quit the college, and visit foreign countries; but his finances were so low, that he was obliged to dispose of his books, to enable him to execute that design.

He left England in June 1655, and visited France, Italy, Turkey, &c. At several places, in the course of this tour, he met with kindness and liberal assistance from the English ambassadors, &c. which enabled him to benefit the more, by protracting his stay, and prolonging his journey. He spent more than a year in Turkey, and returned to England by way of Venice, Germany, and Holland, in 1659. At Constantinople he read over the works of St. Chrysostom, whom he preferred to all the other fathers.

On his return, Barrow was ordained by Bishop Brownrig; and in 1660, he was

chemists were confirmed by Bergman, who gave the earth the name of terra ponderosa. Morveau gave it the name of barote, and Kirwan of barytes; which last was approved by Bergman, and is now universally adopted. Barytes may be obtained in a state of purity, by the calcination of its carbonate or nitrate. It exhibits, when pure, the following properties. 1. Barytes, in a pure form, has a sharp caustic taste, changes vegetable blue colours to green; and serves as the intermedium between oil and water: in these respects it bears a strong resemblance to alkalis. 2. When exposed to the flame of the blow-pipe on charcoal, it melts; boils violently; and forms small globules, which sink into the charcoal. If perfectly free from water, however, it is infusible. 3. If a small quantity of water be added to recently prepared barytes, it is absorbed with great rapidity; prodigious heat is excited; and the water is completely solidified, a sort of hard cement being obtained. A little more water converts this mass into a light bulky powder; and when completely covered with water, the barytes is dissolved. Boiling water should be employed for this purpose, unless sufficient temperature has been produced by the sudden addition of the whole quantity necessary for solution. 4. When the solution, prepared with boiling water, is allowed to cool slowly, it shoots into regular crystals. These have the form of flattened hexagonal prisms, having two broad sides, with two intervening narrow ones; and terminated at each end by a quadrangular pyramid. 5. The crystals are so soluble as to be taken up when heated, merely by their own water of crystallization. When exposed to a stronger heat, they swell, foam, and leave a dry white powder, amounting to about 47 parts from 100 of the crystals. This again combines with water with great heat and violence. At 60° of Fahrenheit, an ounce-measure of water dissolves only 25 grains of the crystals, *i. e.* they require for solution $17\frac{1}{2}$ times their weight of water. Exposed to the atmosphere, they effloresce, and become pulverulent. 6. When added to spirit of wine, and heated in a spoon over a lamp, they communicate a yellowish colour to its flame. 7. The specific gravity of this earth, according to Fourcroy, is 4, but Hassenfratz states it at only 2.374. The former account, however, is the more probable. All its combinations have considerable specific gravity; and hence its name is derived, *viz.* from the Greek word βαρυς, signifying heavy. 8. Barytes does not unite with any of the alkalis.

BASALT, in mineralogy, occurs massive, in blunt and rolled pieces, and sometimes vesicular: its common colour is greyish black, of various degrees of intensity; from this it passes into ash-grey; sometimes to brown, and even in some varieties to raven black. It is dull internally, and the fracture is commonly coarse-grained and uneven. It occurs almost always in distinct concretions, which are usually columnar, and from a few inches to several fathoms, and even to upwards of 100 feet in length. They are sometimes straight, sometimes bent, and either parallel or diverging. In mountains these concretions are collected into larger groupes, of which many together form a hill or a mountain. Sometimes the columns are articulated, and the joints have convex and concave faces. The specific gravity is by Bergman put at 3.0: by Brisson at 2.86: and by Kirwan at 2.98. Before the blow-pipe it easily melts without addition into an opaque black glass. By analysis the constituent parts have been brought out differently by different chemists, but according to Klaproth they are as follow:

Silica	44.50
Alumina	16.75
Oxide of iron	20.00
Lime	9.50
Magnesia	2.25
Oxide of manganese	0.12
Soda	2.60
Water	2.00
	97.62

It is found in vast mountainous beds, in most parts of the world, and almost always accompanies coal. The island of Staffa, on the western coast of Scotland, is entirely composed of basaltic pillars: the Giants Cause-way, on the coast of Antrim, in Ireland, is a huge pavement of straight pillars, running to an unknown distance in the sea: the promontory of Fair-head, a little further to the north, exhibits a continued range, about a mile long, of columns 250 feet in height, and from 10 to 20 in diameter, being the largest yet known.

Basalt is employed as a building stone, and touch stone; as a flux for certain ores of iron; in glass manufactures; in making the common green glass. The vesicular varieties are employed for mill-stones,

BARRULET, in heraldry, the fourth part of the bar, or the one half of the closset: an usual bearing in coat-armour.

BARRULY, in heraldry, is when the field is divided bar-ways, that is across from side to side, into several parts.

BARRY, in heraldry, is when an escutcheon is divided bar-ways, that is across from side to side, into an even number of partitions, consisting of two or more tinctures, interchangeably disposed: it is to be expressed in the blazon by the word *barry*, and the number of pieces must be specified; but if the divisions be odd, the field must be first named, and the number of bars expressed.

Barry-*bendy* is when an escutcheon is divided evenly, bar and bend-ways, by lines drawn transverse and diagonal, interchangeably varying the tinctures of which it consists.

Barry-*pily* is when a coat is divided by several lines drawn obliquely from side to side, where they form acute angles.

BARS, in music, lines drawn perpendicularly through the staves, to divide the notes into equal temporary quantities. By the assistance of these lines, the composer figures the correspondence of the parts of his score. It is also by their assistance that the performer is enabled to keep his time, and that a whole band, however numerous, is regulated and held together.

BARTERING, in commerce, the exchanging of one commodity for another, or the trucking wares for wares, among merchants. Bartering was the original and natural way of commerce, there being no buying till money was invented, though in exchanging, both parties are buyers and sellers. The only difficulty in this way of dealing lies in the due proportioning the commodities to be exchanged, so as that neither party sustain any loss. Although the invention of money has not altogether put an end to barter, yet it has entirely prevented it from appearing in its real form in the books of merchants, as each article is there stated in its money value, and each sale is supposed to be paid for, in the circulating medium of the country, even in cases where no money whatever is made use of in the transaction.

The following example will sufficiently explain the method of proportioning the commodities. Two merchants, A and B, barter; A would exchange 5 *C.* 3 *qr.* 14*lb.* of pepper, worth 3*l.* 10*s.* per *C.* with B for cotton worth 10*d.* per pound; how much cotton must B give A for this pepper?

In order to solve this question, and all others of the same nature, we must first find, by proportion, the true value of that commodity whose quantity is given; which, in the present case, is pepper: and then find how much of the other commodity will amount to that sum, at the rate proposed.

First, to find the value of the pepper, say As 1 *C.* is to 3*l.* 10*s.* so is 5 *C.* 3 *qr.* 14*lb.* to 20*l.* 11*s.* 3*d.* the true value of the pepper.

Then it is easy to conceive that A ought to have as much cotton at 10*d.* per pound, as will amount to 20*l.* 11*s.* 3*d.* which will be found by the following proportion.

As 10*d.* is to 1*lb.* so is 20*l.* 11*s.* 3*d.* to 4*C.* 1 *qr.* 17½*lb.*—And so much cotton must B give A. for his 5 *C.* 3 *qr.* 14*lb.* of pepper.

BARTRAMIA, in botany, is a genus of the Decandria Monogynia class of plants, the calyx of which is a perianthium, cut into five parts: the corolla consists of five wedge-shaped petals; the fruit is globular, and the seeds are four in number, convex on one side, and angular on the other.

BARTSIA, in botany, so named from Dr. Bartsch, the intimate friend of Linnæus, a genus of the Didynamia Angiospermia class of plants, whose flower consists of one petal, having the upper lip longest; the seeds are numerous, small, angular, and inclosed in capsules. There are five species, one called B. gymnandria, grows within the arctic circle, on the north side of the Frozen Ocean in Kamtschatka, where there is no other vegetation.

BARUTH, an Indian measure, containing seventeen gantans: it ought to weigh about three pounds and an half of English avoirdupois.

BARYTES was discovered by Scheele in 1774; and the first account of its properties published by him in his Dissertation on Manganese. This is a very heavy mineral, most frequently of a flesh colour, of foliated texture and brittle, very common in Britain and most other countries, especially in copper mines. It was known by the name of ponderous spar, and was supposed to be a compound of sulphuric acid and lime. Gahn analysed this mineral in 1775, and found that it is composed of sulphuric acid, and the new earth discovered by Scheele. Scheele published an account of the method of obtaining this earth from ponderous spar. The experiments of these

strong, succulent stalks, and leaves of a deep purple colour. This plant requires to be supported, for it will climb to the height of eight or ten feet. The flowers have no great beauty; but the plant is preserved for the odd appearance of the stalks and leaves. It is a native of the East Indies, Amboyna, and Japan. From the berries a beautiful colour is drawn: when used for painting does not continue very long, but changes to a pale colour; and has also been used for staining calicoes in India.

BASEMENT, in architecture, a base continued a considerable length, as round a house, room, &c.

BASILIC, in ancient architecture, a term used for a large hall, or public place, with isles, porticoes, galleries, tribunals, &c. where princes sat and administred justice in person. But the name has since been tranferred, and is now applied to such churches, temples, &c. which by their grandeur as far surpass other churches as princes' palaces do private houses: as also to certain spacious halls in princes' courts, where the people hold their assemblies: and to such stately buildings as the Palais at Paris, and the Royal Exchange at London, where merchants meet and converse.

BASILICON. See PHARMACY.

BASILICUS, in astronomy, *Cor Leonis*, a fixed star of the first magnitude in the constellation Leo. See LEO.

BASKET, a kind of vessel made of twigs interwoven together, in order to hold fruit, earth, &c.

The best baskets are made of osiers, which thrive in moist places. To form an osier bed, the land should be divided into plots, eight or ten feet broad, by narrow ditches, and if there is a power of keeping water in these places, by means of a sluice, it is of the greatest importance in dry seasons. The common osier is cut at three years, but that with yellow bark not till the fourth. When the osiers are cut down, those that are intended for white work, such as baskets used in washing, are to be stripped of their bark while green. This is done by means of a sharp instrument, fixed into a firm block, over which the osiers are passed, and stripped of their covering with great velocity. They are then dried, and put in bundles for sale. Before they are worked, they must be soaked in water, which renders them flexible. The basket-maker usually sits on the ground to his business. Hampers and other coarse work are made of osiers without any previous preparation. The ancient Britons were celebrated for their ingenuity in making baskets, which they exported in great numbers. They were often of very elegant workmanship, and bore a high price.

BASKETS *of earth*, in the military art, are small baskets used in sieges, on the parapet of a trench, being filled with earth. They are a foot and a half high, about a foot and a half diameter at the top, and eight or ten inches at bottom; so that being set together, there is a sort of embrassures left at their bottoms, through which the soldiers fire, without exposing themselves.

BASKET *fish*, a kind of star-fish caught in the seas of North America.

BASKET *salt*, that made from salt springs, being purer, whiter, and composed of finer grains than the common brine salt.

BASS, in music, that part of a concert which is most heard, which consists of the gravest and deepest sounds, and which is played on the largest pipes or strings of a common instrument, as of an organ, lute, &c. or on instruments larger than ordinary, for that purpose, as bass-viols, bassoons, bass-hautboys, &c. The bass is the principal part of a musical composition, and the foundation of harmony; for which reason it is a maxim among musicians, that when the bass is good, the harmony is seldom bad.

BASS, *counter*, is a second or double bass, where there are several in the same concert.

BASS, *figured*, is that which, while a certain chord or harmony is continued by the parts above, moves in notes of the same harmony. Thus, if the upper parts consist of C, E, G, (the harmony of C,) and while they are continued, the bass moves from C, the fundamental note of that harmony, to E, another note of the same harmony; that bass is called a figured bass.

BASS, *fundamental*, is that which forms the tone or natural foundation of the incumbent harmony; and from which, as a lawful source, that harmony is derived: that is, if the harmony consist of the common chord of C, C will be its fundamental bass, because from that note the harmony is deduced; and if, while that harmony is continued, the bass be changed to any other note, it ceases to be fundamental, because it is no longer the note from which that harmony results and is calculated.

BASS *ground*, is that which starts with some subject of its own, and continues to

be repeated throughout the movement, while the upper part or parts pursue a separate air, and supply the harmony. This kind of bass is productive of a monotonous melody, and has long since been rejected as a restraint upon the imagination.

Bass, *thorough*, is the art by which harmony is superadded to any proposed bass, and includes the fundamental rules of composition. It is theoretical and practical: the former comprehends the knowledge of the connection and disposition of the several chords, the latter is conversant with the manner of taking the several chords on an instrument.

BASSANTIN (James), a Scotch astronomer, of the 16th century, born in the reign of James IV. of Scotland. He was a son of the laird of Bassantin, in the Merse. After finishing his education at the University of Glasgow, he travelled through Germany and Italy, and then settled in the University of Paris, where he taught mathematics with great applause. Having acquired some property in this employment, he returned to Scotland in 1562, where he died six years after.

From his writings it appears he was no inconsiderable astronomer, for the age he lived in; but, according to the fashion of the times, he was not a little addicted to judicial astrology. It was doubtless to our author that Sir James Melvil alludes in his Memoirs, when he says, that his brother Sir Robert, when he was using his endeavours to reconcile the two queens, Elizabeth and Mary, met with one Bassantin, a man learned in the high sciences, who told him, "that all his travel would be in vain; for," said he, "they will never meet together; and next, there will never be any thing but dissembling and secret hatred for a while, and at length captivity and utter wreck to our queen from England." He added, that "the kingdom of England at length shall fall, of right, to the crown of Scotland: but it shall cost many bloody battles; and the Spaniards shall be helpers, and take a part to themselves for their labour." A prediction in which Bassantin partly guessed right, which it is likely he was enabled to do, from a judicious consideration of probable circumstances and appearances.

Bassantin's works are, on astronomy, music, and various parts of the mathematics.

BASSET, a game at cards, said to have been invented by a noble Venetian, for which he was banished. The persons concerned in it are a dealer, or banker, his assistant, who supervises the losing cards, and the punter, or any one who plays against the banker.

BASSIA, in botany, so called in honour of Ferdinando Bassi; a genus of the Dodecandria Monogynia class and order. Natural order of Dumosæ; Sapotæ, Jussieu. Essential character. Calyx four-leaved; corolla eight-cleft; tube inflated; stamina 16; drupe five-seeded. There are 3 species, of which B. longifolia is a lofty tree, with the outmost branches recurved, thickish, and covered with a grey down; berry fleshy, milky, with five seeds, one in each cell; they are oblong, slightly compressed, sometimes acuminate at each end, sometimes only at the base, very smooth, shining, yellow, with a white band; native of Malabar and Ceylon.

BASSOON, a musical instrument of the wind sort, blown with a reed, furnished with eleven holes, and used as a bass in a concert of hautboys, flutes, &c. To render this instrument more portable, it is divided into two parts, whence it is also called fagot. Its diameter at bottom is nine inches, and its holes are stopped like those of a large flute. The compass of the bassoon comprehends three octaves, extending from double B flat, to B above the treble-cliff note. The scale includes every semitone between its extremes, and its tone is so assimilated to that of the hautboy, as to render it the most proper bass to that instrument.

BASSO-RELIEVO, or Bass-relief, a piece of sculpture, where the figures or images do not protuberate, jet, or stand out far above the plane on which they are formed. Whatever figures or representations are thus cut, stamped, or otherwise wrought, so that not the entire body, but only a part of it is raised above the plane, are said to be done in relief, or relievo: and when that work is low, flat, and but a little raised, it is called low relief; when a piece of sculpture, a coin, or a medal, has its figure raised so as to be well distinguished, it is called bold, and we say its relief is strong.

The origin of basso-relievo is said to have been described in the story of the maid of Corinth, related by Pliny, who says that the Sicyonian potter, her father, invented the following method of taking likenesses. His daughter being in love with a youth going to a foreign country, she circumscribed the

shadow of his face with lines on the wall by lamp-light. Her father took the impression in clay and baked it among his vases.

BASSOVIA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla five-cleft; spreading, with a very short tube; berry ovate, knobbed, with many seeds. There is but one species; *viz.* B. sylvatica; the stems herbaceous, three or four feet high, branched; flowers in axillary corymbs, green and very small. Native of Guiana, in wet forests, flowering and fruiting in June.

BASS-VIOL, a musical instrument of a like form with that of a violin, but much larger. It is struck with a bow as that is, has the same number of strings, and has eight stops, which are subdivided into semi-stops; its sound is grave, and has a much nobler effect in a concert than that of the violin.

BASTARD, a natural child, or one born of an unmarried woman. By the laws of England, a bastard is incapable of inheriting land, as heir to his father; nor can any one inherit land as heir to him, except the children of his own body, born in wedlock; for by order of law, a bastard has no relation, of which it takes any notice, and he himself is accounted the first of his family. If a man marries a woman that is big with child by another, who was not her husband, and the child is born within the espousals, then it shall be deemed the child of the husband, and no bastard, though it were born but a day after the marriage; but this is understood when the parties are of age, and there is no apparent impossibility on the man's side. If a woman be with child by a man who afterwards marries her, and then the child is born, this child is no bastard; but if a man hath issue by a woman, before marriage, and afterwards marries her, the first issue is a bastard, by our laws, but legitimate by the civil law. If a woman elope from her husband, and he be within the four seas, her issue shall not be a bastard by our laws, though by the special law it shall: and if the wife continues in adultery, and has issue, it is a bastard in our law. If the husband and wife consent to live separate, and have issue afterwards, it shall be accounted legitimate, because the access of the husband shall be presumed; but if the contrary be found, it shall be a bastard.

BASTION, in the modern fortification, a huge mass of earth, faced usually with sods, sometimes with brick, and rarely with stone, standing out from a rampart, whereof it is a principal part, and is what, in the ancient fortification, was called a bulwark. A bastion consists of two faces and two flanks; the faces include the angle of the bastion; and their union makes the outmost, or the saliant angle, called also the angle of the bastion; and the union of the two faces to the two flanks makes the side-angles, called also the shoulders, or epaules; and the union of the two other ends of the flanks to the two curtains makes the angles of the flanks. See FORTIFICATION.

BASTON, in law, one of the servants to the warden of the Fleet-prison, who attends the king's courts with a red staff for taking into custody such as are committed by the court. He also attends on such prisoners as are permitted to go at large by licence.

BASTON, or BATOON, in heraldry, a kind of bend, having only one third of the usual breadth. The baston does not go from side to side, as the bend or scarf does, being in the form of a truncheon. Its use is a note or mark of bastardy.

BASTONADE, or BASTINADO, a kind of punishment inflicted by beating the offender with a stick. This sort of beating, among the ancient Greeks and Romans, was the punishment commonly inflicted on criminals that were freemen, as that of whipping was on the slaves. We find some instances of this sort of discipline among the Hebrews; and it is a penalty used in the east at this day.

BAT. See VESPERTILIO.

BAT *fowling*, a method of catching birds in the night, by lighting some straw, or torches, near the place where they are at roost; for upon beating them up, they fly to the flame, where being amazed, they are easily caught in nets, or beat down with bushes fixed to the end of poles, &c.

BATH, *knights of the*, a military order in England, supposed to have been instituted by Richard II. who limited the number of knights to four; however, his successor, Henry IV. increased them to forty-six. Their motto is "Tria juncta in uno," signifying the three theological virtues.

This order received its denomination from a custom of bathing before the knights received the golden spur. They wear a red ribband beltwise, appendant to which is the badge or symbol of the order, which is a sceptre, rose, thistle, and three imperial crowns conjoined within a circle, upon which circle is the motto, and all of pure gold. Each knight wears a silver star of eight

points upon the left breast of his upper garment.

The order of the bath, after remaining many years extinct, was revived under George the First, by a solemn creation of a great number of knights.

BATH-*col*, the daughter of a voice. So the Jews call one of their oracles, which is frequently mentioned in their books, especially the Talmud, being a fantastical way of divination invented by the Jews themselves, not unlike the sortes virgilianæ of the heathens. However, the Jewish writers call this a revelation from God's will, which he made to his chosen people, after all verbal prophecies had ceased in Israel.

BATIS, in botany, a genus of the Dioecia Tetrandria class and order. Essential character: male ament four-fold, imbricate; calix and corolla none. Female ament ovate; involucre two-leaved; calyx and corolla none; stigma two-lobed, sessile; berries conjoined, four-seeded. There is but one species, *viz.* B. maritima, a shrub four feet high, with a round ash-coloured stem, much branched; stigmas white; fruits yellow or greenish yellow. The plant is salt to the taste, and is burnt for barilla at Carthagena. Native of the Caribbee islands and the neighbouring continent.

BATMAN, in commerce, a kind of weight used at Smyrna, containing six okes of four hundred drachms each, which amount to 16 pounds, 6 ounces, and 15 drachms of English weight.

BATTALION, a small body of infantry, ranged in form of battle, and ready to engage.

A battalion usually contains from 5 to 800 men; but the number it consists of is not determined. They are armed with firelocks (pikes being quite laid aside) swords and bayonets; and divided into thirteen companies, one of which is grenadiers. They are usually drawn up with three men in file, or one before another. Some regiments consist but of one battalion, others are divided into four or five.

BATTEL, a trial by combat, which was anciently allowed by our laws, where the defendant, in an appeal of murder or felony, might fight with the appellant, and make proof thereby, whether he were culpable or innocent. This mode of trial was used also in one civil case, namely, upon an issue joined in a writ of right; but as the writ of right itself is now disused, this course of trial is only matter of speculation.

BATTEN, a name that workmen give to a scantling of wooden stuff, from two to four inches broad, and about one inch thick; the length is pretty considerable, but undetermined.

BATTERING, the attacking a place, work, or the like, with heavy artillery. To batter in breach is to play furiously on a work, as the angle of a half moon, in order to demolish and make a gape therein. In this they observe never to fire a piece at the top, but all at the bottom, from three to six feet from the ground. The battery of a camp is usually surrounded with a trench, and pallisadoes at the bottom, with two redoubts on the wings, or certain places of arms, capable of covering the troops which are appointed for their defence.

BATTERY, in the military art, a parapet thrown up to cover the gunners and men employed about the guns from the enemy's shot. This parapet is cut into embrasures for the cannon to fire through. The height of the embrasures, on the inside, is about three feet; but they go sloping lower to the outside. Their wideness is two or three feet, but open to six or seven on the outside. The mass of earth that is betwixt two embrasures is called the merlon. The platform of a battery is a floor of planks and sleepers, to keep the wheels of the guns from sinking into the earth; and is always made sloping towards the embrasure, both to hinder the reverse and to facilitate the bringing back of the gun.

BATTERY, in law, the striking, beating, or offering any violence to another person, for which damages may be recovered. But if the plaintiff made the first assault the defendant shall be quit, and the plaintiff amerced to the king for his false suit. Battery is frequently confounded with assault, though in law they are different offences; for in the trespass for assault and battery one may be found guilty of assault, yet acquitted of the battery; there may, therefore, be assault without battery, but battery always implies an assault.

BATTERY. See ELECTRICITY and GALVANISM.

BATTLE, a general engagement between two armies, in a country sufficiently open for them to encounter in front, and at the same time; or, at least, for the greater part of the line to engage. Other great actions, though of a longer duration, and even attended with a greater slaughter, are only called fights.

The loss of a battle frequently draws with it that of the artillery and baggage; the

consequence of which is, that as the army beaten cannot again look the enemy in the face till these losses have been repaired, it is forced to leave the enemy a long time master of the country, and at liberty to execute all their schemes; whereas a great fight lost is rarely attended with the loss of all the artillery, and scarcely ever of the baggage. See TACTICS.

BATTLE, *naval*, the same with a sea-fight, or engagement between two fleets of men of war. Before a naval battle every squadron usually subdivides itself into three equal divisions, with a reserve of certain ships out of every squadron to bring up their rear. Every one of these observing a due birth and distance are in the battle to second one another; and the better to avoid confusion and falling foul of each other, to charge, discharge, and fall off by threes or fives, more or less, as the fleet is greater or smaller. The ships of reserve are instructed either to succour and relieve those that are any way in danger, or to supply and put themselves in the place of those that shall be made unserviceable. See TACTICS.

BAUERA, in botany, a genus of the Polyandria Monogynia class and order. Calyx eight-leaved; petals eight; capsule two-celled, two-valved, many-seeded. One species, which is a native of New Holland.

BAUHINIA, in botany, so called in honour of the two famous botanists John and Caspar Bauhin, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ; Leguminosæ, Jussieu. Essential character: calyx five-cleft, deciduous; petals expanding, oblong, with claws, the upper one more distant, all inserted into the calyx, legume. There are 13 species, of which B. aculeata is an erect shrub, the height of a man; the trunk and branches are very prickly; leaves roundish; the two lobes also are roundish and blunt; the flowers are large, white, and have a scent which is somewhat unpleasant; sometimes the fold of the calyx is entire, not cloven. Mr. Miller says that it rises to the height of sixteen or eighteen feet in Jamaica where it grows plentifully, and the other sugar islands in America; that the stalks are terminated by several long spikes of yellow flowers, which are succeeded by bordered pods, about three inches long, containing two or three swelling seeds; that these pods are glutinous, and have a strong balsamic scent, as have also the leaves when bruised; and that it is called in America the Indian savin tree, from its strong odour, somewhat resembling the common savin.

BAWDY-*house*, a house of ill fame, to which lewd persons of both sexes resort, and there have criminal conversation.

The keeping a bawdy-house is a common nuisance, not only on account that it endangers the public peace by drawing together debauched and idle persons, and promoting quarrels, but likewise for its tendency to corrupt the manners of the people. And, therefore, persons convicted of keeping bawdy-houses are punishable by fine and imprisonment; also liable to stand in the pillory, and to such other punishment as the court, at their discretion, shall inflict.

BAXTERIANS, in church history, a sect of Christians who look up to the celebrated Richard Baxter as their founder, and who make the tenets of that worthy man the foundation of their faith. The object of Baxter was a hopeless cause, it was to reconcile the opinions of Calvin and Arminius, and his scheme is called the middle scheme. Although the old adage, that the middle path is the safest, may be true in many things relating to the conduct of life, yet where truth and religion are concerned there can be no middle way. There is no medium between what is true and what is erroneous. Baxter taught that God elected some whom he determined to save without any foresight of their good works, and that others to whom the gospel is preached have the means of salvation put into their hands. He contended that the merits of Christ's death, of which he appears to have had no precise idea, are to be applied to believers only, but all men are in a state capable of salvation. Mr. Baxter also assumed that there may be a certainty of perseverance here; and yet he cannot tell whether a man may not have so weak a degree of saving grace as to lose it again.

BAYER, (JOHN) in biography, a German lawyer and astronomer of the latter part of the 16th and beginning of the 17th century, but in what particular year or place he was born is not certainly known: however, his name will be ever memorable in the annals of astronomy, on account of that great and excellent work which he first published in the year 1603, under the title of "Uranometria," being a complete celestial atlas, or large folio charts of all the constellations, with a nomenclature collected from all the tables of astronomy, ancient and modern, with the useful invention of denoting the stars in every constellation by

the letters of the Greek alphabet, in their order, and according to the order of magnitude of the stars in each constellation. By means of these marks the stars of the heavens may, with as great facility, be distinguished and referred to, as the several places of the earth are by means of geographical tables; and as a proof of the usefulness of this method our celestial globes and atlasses have ever since retained it; and hence it is become of general use through all the literary world; astronomers in speaking of any star in the constellation, denoting it by saying it is marked by Bayer, α, or β, or γ, &c.

Bayer lived many years after the first publication of this work, which he greatly improved and augmented by his constant attention to the study of the stars. At length, in the year 1627, it was republished under a new title, *viz*, "Cœlum Stellatum Christianum, that is, the Christian Stellated Heaven, or the Starry Heavens Christianized:" for in this work, the Heathen names and characters, or figures of the constellations, were rejected, and others taken from the scriptures were inserted in their stead, to circumscribe the respective constellations. But this was considered too great an innovation, and we find in the later editions of the work that the ancient figures and names were restored.

BAYONET, in the military art, a short broad dagger, formerly with a round handle fitted for the bore of a firelock, to be fixed there after the soldier had fired; but they are now made with iron handles and rings that go over the muzzle of the firelock, and are screwed fast so that the soldier fires with his bayonet on the muzzle of his piece, and is ready to act against horse.

BAYS, in commerce, a sort of open woollen stuff, having a long knap, sometimes frized, and sometimes not. This stuff is without wale, and is wrought in a loom with two treddles like flannel. It is chiefly manufactured at Colchester and Bocking in Essex, where there is a hall called the Dutch bay hall, or raw hall.

BEACON, a public signal, to give warning against rocks, shelves, invasions, &c.

The corporation of the Trinity-house are empowered to set up beacons wherever they shall think necessary, and if any destroy or take them down he shall forfeit 100*l.* or be *ipso facto*, out-lawed. There are other beacons put up to give warning of the approach of an enemy; these are made by putting pitch barrels upon a long pole, to be set upon an eminence so as they may be seen afar aff; for the barrels being fired, the flame in the night-time, and the smoke in the day, give notice, and in a few hours may alarm the whole kingdom upon an approaching invasion, &c.

BEADS, in the arts, are small globules chiefly used for necklaces, and are made of pearl, steel, garnet, coral, diamond, amber, crystal, paste, glass, &c. There is a large trade chiefly of coral, amber, and glass beads, carried on with the uninformed inhabitants of the coast of Africa and the East India islands. Roman Catholics make use of beads in rehearsing their prayers, and they are applied to the same use among the dervices and other religious sects in the East.

BEAD, in architecture, a round moulding commonly made upon the edge of a piece of stuff, in the Corinthian and Roman orders, cut or carved in short embossments like beads in necklaces.

Sometimes a plain bead is set on the edge of each fascia of an architrave, and sometimes likewise an astragal is thus cut. A bead is often placed on the lining-board of a door-case, and on the upper edges of skirting-boards.

BEAK, or BEAK-*head*, of a ship, that part without the ship, before the forecastle, which is fastened to the stem, and is supported by the main knee. This name is appropriated to ships whose forecastle is square or oblong, a circumstance common to all vessels which have two or more tiers of guns. In smaller ships the forecastle is generally shaped like a parabola, the vertex of which lies immediately above the stem. The strong projecting pointed beaks used by the ancients in time of battle are entirely disused since the invention of gunpowder.

BEAKED, in heraldry, a term used to express the beak and bill of a bird. When the beak and legs of a fowl are of a different tincture from the body, we say beaked and membered of such a tincture.

BEAM, in architecture, the largest piece of wood in a building, which lies across the walls and serves to support the principal rafters of the roof, and into which the feet of these rafters are framed. No building has less than two of these beams, *viz.* one at each end. Into these the girders of the garret roof are also framed; and if the building be of timber the teazle tenons of the posts are framed into them. The proportion of beams in or near London are fixed by statute.

Beam *compass*, an instrument consisting of a square wooden or brass beam, having sliding sockets that carry steel or pencil points: they are used for describing large circles where the common compasses are useless.

Beams *of a ship*, are the great main cross-timbers which hold the sides of the ship from falling together, and which also support the decks and orlops: the main beam is next the main mast, and from it they are reckoned by first, second, third beam, &c. the greatest beam of all is called the mid-ship beam.

Beam, or *Roller*, among weavers, a long and thick wooden cylinder, placed lengthways on the back part of the loom of those who work with a shuttle.

That cylinder on which the stuff is rolled as it is weaved is also called the beam or roller, and is placed on the fore part of the loom.

BEAN. See Vicia.

BEAR. See Ursus.

Bear, in astronomy. See Ursa.

Bear, in heraldry. He that has a coat of arms is said to bear in it the several charges or ordinaries that are in his escutcheon.

Bear, in gunnery. A piece of ordnance is said to come to bear, when it lies right with, or directly against the mark.

BEAR'S *Breech*, in botany. See Acanthus.

BEARD, the hair growing on the chin, and adjacent parts of the face, chiefly of adults and males.

Various have been the ceremonies and customs of most nations in regard of the beard. The Tartars, out of a religious principle, waged a long and bloody war with the Persians, declaring them infidels, merely because they would not cut their whiskers, after the rite of Tartary: and we find, that a considerable branch of the religion of the ancients consisted in the management of their beard.

Ecclesiastics have sometimes been enjoined to wear, and at other times have been forbid the wearing, the beard; and the Greek and Romish churches have been a long time by the ears about their beards. To let the beard grow, in some countries, is a token of mourning, as to shave it is the like in others.

The Greeks wore their beards till the time of Alexander the Great, that prince having ordered the Macedonians to be shaved, for fear it should give a handle to their enemies: the Romans did not begin to shave till the year of Rome 454. Nor did the Russians cut their beards till within these few years, that Peter the Great, notwithstanding his injunctions upon them to shave, was obliged to keep on foot a number of officers to cut off, by violence, the beards of such as would not otherwise part with them.

Beard *of a comet*, the rays which the comet emits towards that part of the heaven to which its proper motion seems to direct it: in this the beard of a comet is distinguished from the tail, which is understood of the rays emitted towards that part from whence its motion seems to carry it.

BEARER *of a bill of exchange*, the person in whose hands the bill is, and in favour of whom the last order was made.

When a bill is made payable to the bearer, it is understood to be payable to him in whose hands it is after it becomes due.

Bearers, in heraldry. See Supporters.

BEARING, in navigation and geography, the situation of one place from another, with regard to the points of the compass; or the angle which a line drawn through the two places makes with the meridians of each.

The bearings of places on the ground are usually determined from the magnetic needle, in the managing of which consists the principal part of surveying, since the bearing or distance of a second point from a first being found, the place of that second is determined; or the bearings of a third point from two others, whose distance is known, being found, the place of the third is determined instrumentally. But to calculate trigonometrically, there must be more data.

Bearing, in the sea language. When a ship sails towards the shore, before the wind, she is said to bear in with the land or harbour. To let the ship sail more before the wind, is to bear up. To put her right before the wind, is to bear round. A ship that keeps off from the land, is said to bear off. When a ship that was to windward comes under another ship's stern, and so gives her the wind, she is said to bear under her lee, &c. There is another sense of this word, in reference to the burden of a ship; for they say a ship bears, when having too slender or lean a quarter, she will sink too

deep into the water with an over light freight, and thereby can carry but a small quantity of goods.

BEARING *of a piece of timber*, among carpenters, the space either between the two fixed extremities thereof, when it has no other support, which they call bearing at length, or between one extreme and a post, brick wall, &c. trimmed up between the ends to shorten its bearings.

BEAT, in music, a transient grace note, struck immediately before the note it is intended to ornament. The beat always lies half a note beneath its principal, and should be heard so closely upon it, that they may almost seem to be struck together.

BEAT *of drum*, in the military art, to give notice by beat of drum of a sudden danger; or that scattered soldiers may repair to their arms and quarters, is to beat an alarm, or to arms; also to signify, by different manners of sounding a drum, that the soldiers are to fall on the enemy; to retreat before, in, or after an attack; to move, or march, from one place to another; to treat upon terms, or confer with the enemy; to permit the soldiers to come out of their quarters at break of day; in order to repair to their colours, &c. is to beat a charge, a retreat, a march, &c.

BEATING *gold and silver*. See GOLD BEATING.

BEATING *time*, in music, a method of measuring and marking the time for performers in concert, by the motion of the hand and foot up and down successively, and in equal times. Knowing the true time of a crotchet, and supposing the measure actually subdivided into four crotchets, and the half measure into two, the hand or foot being up, if we put it down with the very beginning of the first note or crotchet, and then raise it with the third, and then down with the beginning of the next measure; this is called beating the time; and by practice a habit is acquired of making this motion very equal. Each down and up is sometimes called a time, or measure.

The general rule is, to contrive the division of the measure so, that every down and up of the beating shall end with a particular note, on which very much depends the distinctness, and, as it were, the sense of the melody. Hence the beginning of every time or beating in the measure is reckoned the accented part thereof.

If time be common, or equal, the beating is also equal; two down and two up, or one down and one up: if the time be triple, or unequal, the beating is also unequal; two down and one up.

BEATINGS, in music, those regular pulsative heavings or swellings of sound, produced in an organ by pipes of the same key when they are not exactly in unison, *i. e.* when their vibrations are not perfectly equal in velocity; not simultaneous and coincident.

BEATS, in music, are certain pulsations of two continued sounds, as in an organ, that are out of tune, occasioned by warring vibrations that prevent coincidence in any two concords. This phenomenon Dr. Smith has made the foundation of a system of temperament. In tuning musical instruments, especially organs, it is a known thing, that while a consonance is imperfect it is not smooth and uniform as when perfect, but interrupted with very sensible undulations or beats, which while the two sounds continue at the same pitch succeed one another in equal times, and in longer and longer times, while either of the sounds approaches gradually to a perfect consonance with the other, till at last the undulations vanish, and have a smooth and uniform consonance. These beats are of use in tuning an organ to any degree of exactness. The beats of two dissonant organ pipes resemble the beating of the pulse to the touch: and like the human pulse in a fever, the more dissonant are the sounds the quicker they beat, and the slower as they become better in tune, till at length they are lost in the coincident vibrations of the two sounds.

BEATS, in a watch or clock, are the strokes made by the fangs or pallets of the spindle of the balance, or of the pads in a royal pendulum. To find the beats of the balance in all watches going, or in one turn of any wheel. Having found the number of turns which the crown-wheel makes in one turn of the wheel you seek for, those turns of the crown-wheel multiplied by its notches give half the number of beats in that one turn of the wheel. For the balance or swing has two strokes to every tooth of the crown-wheel, inasmuch as each of the two pallets hath its blow against each tooth of the crown-wheel; whence it is that a pendulum that beats seconds has in its crown-wheel only 30 teeth. See WATCH-WORK.

BEAVER, in zoology. See CASTOR.

BEAUTY, a general term for whatever excites in us pleasing sensations, or an idea of approbation.

Hence the notion annexed to beauty may be distinguished into ideas and sensations: the former of which occupy the mind;

the latter affect the heart: thus, an object may please the understanding without interesting the sense; and on the other hand, we perceive agreeable sensations, excited by some objects, whose ideas are no way related to any thing that is praiseworthy.

It is, on account of these distinctions, that the difficulty lies of fixing an universal characteristic of beauty, in regard that the persons vary, according to their different turns of mind, and habitudes of body, and consequently the relations of objects to those ideas and sensations do in like manner vary; whence arise the different opinions of beauty in painting, women, &c.

Beauty, in its most extensive sense, may perhaps be properly defined, that quality or union of qualities in the objects of perception, whether they be material, intellectual, or moral, which is best calculated to excite emotions of pleasure in the minds of intelligent creatures. We say calculated to produce these effects in the minds of intelligent creatures, because, although beauty is, like truth, unchangeable in itself, it is only in proportion to the measure of our intelligence, that we are capable of perceiving and enjoying it. Hence the distinction between beauty and taste: the former, the object, ever existing, ever the same; the latter, the power of perception, fluctuating and changing, in proportion to the perfection of our organs of sense and the improvement of our reasoning faculties. That the organs of sense vary in their degrees of perfection in different men, experience every day demonstrates: that the eye of one, the ear of another, the palate, the smell, or the touch of a third, is by nature formed with more exquisite workmanship than in others, no one can doubt; and that these organs of sense can be again rendered still more correct by their particular education or frequent practice, is equally certain. Thus the man whose eye has been long accustomed to measure distances, shall seldom be under the necessity of recurring to the rule; the accomplished artist shall in a moment discover the various colours, and the proportions of each required to produce any complex tint, or, like Apelles, draw the line marking the scarcely perceptible distinction between excellence and perfection.

Beauty, as opposed to deformity, is as goodness to evil, as truth to falsehood, or as right to wrong, and may therefore be considered as an outward demonstration vouchsafed by the Almighty, to bring us, by analogy, to the contemplation of those divine attributes by which we are bound to regulate our lives in this material world, that we may be fitted for that state of purity and happiness which we are promised in the world of spiritual existence. If this conclusion be admitted, it is no longer a question why beauty gives us pleasure, it is sufficient that it does so.

But if mankind are not by nature equally endowed with the powers of discriminating or judging of beauty, what is the standard or rule by which we are to ascertain what is really beautiful, much less the different degrees of beauty which any given object presents? for will not each man say, my judgment is right; your's, inasmuch as you differ from me, wrong.

To this, and similar objections, we should not hesitate to reply thus: Although no individual can properly be considered a competent and unerring judge, mankind, in the aggregate may; and we can therefore safely rest satisfied, that what the wisest, the most virtuous, and the most contemplative men of all ages have agreed to sanction by their approval, is right. Taste may be, for a time, perverted by fashion, meritricious charms may usurp the rank of beauty, ostentation may personate virtue; but truth and justice will at length prevail, whilst the frivolity or caprice of a day will be soon forgotten.

The surest method, therefore, nay perhaps the only means by which we can expect to perfect our taste so as to be enabled to relish the higher beauties which either the productions of nature or art present, is by an early and close application to the study and contemplation of those works which have proved impervious to the shafts of criticism, and which have been the admirations of ages.

Such are the writings of the best ancient authors, whether in prose or verse, such the astonishing remains of Greek art, which, long hidden in the bowels of the earth, were restored to light under the happy auspices of Lorenzo de Medici and Leo the Tenth. Next to these, as authorities, we may class the best established works of modern date; and particularly those which appeared soon after the revival of letters and arts; mankind having had, in cases of this description, more leisure and opportunity to correct the errors and prejudices to which contemporary opinion is subjected, than can have been possible with respect to very recent productions.

Inquiries concerning beauty have em-

ployed the pen of many ingenious and learned authors of all ages; the subject however is, like nature, inexaustible, and, like her, perhaps, beyond the reach of human talents fully to comprehend, or satisfactorily to explain. Dr. Hutchinson's theory of beauty ascribes it to "uniformity amidst variety," (see "Hutchison's Inquiry") but another writer (see "Reid's Essay on the Intellectual Powers of Man," ch. iv.) observes that beauty is found in things so various and so very different in nature, that it is difficult to say wherein it consists, or what can be common to all the objects in which it is found. Hogarth, in his "Analysis of Beauty," considers the elements of beauty to be fitness, variety, uniformity, simplicity, intricacy, and quantity: whereas Mr. Burke in his "Inquiry respecting the Sublime and Beautiful," excludes from the number of real causes of beauty, the proportion of parts, fitness, or that idea of utility which consists in a part's being well adapted to answer its ends, and also perfection.

Opinions so contradictory may well justify the hypothesis that beauty is more readily felt than described; and we may set down contented that we receive light and heat from the sun, although ignorant whether it proceeds from a burning orb or a huge stone.

As the attainment of beauty is a principal aim of the fine arts, the subject will necessarily again fall under discussion as connected with each of them in particular. See ARTS, *Fine*, POETRY, PAINTING, DRAWING, SCULPTURE, ENGRAVING, DANCING.

BECHERA, in botany, a genus of the Pentandria Digynia class and order. Calyx five-cleft, superior, with a globular tube; coral five-petalled; capsule two-celled, two-valved. One species.

BECKETS, in sea language, any thing used to confine loose ropes, tackles, or spars in a convenient place; hence beckets are either large hooks, or short pieces of rope with a knot on one end, and an eye in the other; or formed like a circular wreath; or they are a sort of wooden brackets.

BEE. See APIS.

BEES, *management of*. It is agreed by the most judicious observers that the apiary, or place where bees are kept, should face the south, and be situated in a place neither too hot nor too much exposed to the cold; that it be near the mansion-house on account of the convenience of watching them; but so situated as not to be exposed to noisome smells, or to the din of men or cattle; that it be surrounded with a wall, which, however, should not rise above three feet high; that, if possible, a running stream be near them; or if that cannot be, that water be brought near them in troughs, as they cannot produce either combs, honey, or food for their maggots, without water: and that the garden in which the apiary stands be well furnished with such plants as afford the bees plenty of good pasture. Furze, broom, mustard, clover, heath, &c. have been found excellent for this purpose. Hives have been made of different materials, and in different forms, according to the fancy of people of different ages and countries. Not only straw, which experience now proves to be rather preferable to every thing else, but wood, horn, glass, &c. have been used for the construction of them. Single box hives, however, when properly made answer very well, and when painted last long. They have several advantages above straw hives, they are quite cleanly, and always stand upright; they are proof against mice, and are cheaper in the end than straw hives, for one box will last as long as three of them. They are, however, rather colder in winter; but a proper covering will prevent all danger from that quarter. Straw hives are easiest obtained at first, and have been used and recommended by the best of bee-masters. If the swarm be early and large it will require a large hive, but if otherwise, the hive should be proportionably less. If the bees appear to want more room, it can easily be enlarged by putting a roll or two below it; but if it be heavy enough for a stock hive it will do, although it should not be quite full of combs. Any person (says Mr. Bonner) who intends to erect an apiary must take particular care to have it filled with proper inhabitants. He must be peculiarly attentive to this, as all his future profit and pleasure, or loss and vexation, will, in general, depend upon it. He must, therefore, pay the utmost attention to the choice of his stock-hives; for the man who takes care to keep good stock-hives will gain considerably by them; but he who keeps bad ones, will, besides a great deal of trouble and little or no success, soon become a broken bee-master. In September every stock-hive ought to contain as much honey as will supply the bees with food till June following; and as many bees as will preserve heat in the hive, and therefore resist the severity of a cold winter, and act as so many valiant soldiers to defend the commu-

nity from the invasions of foreign enemies in spring. They should be full of combs and well stored with bees and honey, and should weigh at least 30*lb.* each, if heavier so much the better; for light hives run a great risk of perishing by famine, unless the bees are supplied with food; whereas a well-chosen hive of 30*lb.* weight, allowing 12*lb.* for the empty hive, bees, combs, &c. will contain 18*lb.* of honey, which will supply the bees with food till June; a time when it may be presumed they will find abundance of provisions for themselves among the flowers. When a choice can be obtained the youngest hive should always be preferred, because old hives are liable to vermin and other accidents. But although a hive should be four or five years old it should not be rejected, if it possess these two essential qualities, plenty of bees and abundance of honey.

Bees first swarm in May or in the end of April; but earlier or later according to the warmth of the season. They seldom swarm before ten in the morning, and seldom later than three in the afternoon. We may know when they are about to swarm by clusters of them hanging on the outside of the hive. But the most certain sign is when the bees refrain from going into the fields though the season be inviting. Just before they take flight there is an uncommon silence in the hive; after this, as soon as one takes flight they all follow. Before the subsequent swarmings there is a great noise in the hive, which is supposed to be occasioned by a contest whether the young or old queen should go out. When the bees of a swarm fly too high, they will descend lower upon throwing handfuls of sand or dust among them, which they probably mistake for rain. For the same purpose it is usual to beat on a kettle or frying-pan; this practice may have taken its rise from observing that thunder or any great noise prompts bees in the fields to return home. As soon as the swarm is settled, the bees which compose it should be got into a hive with all convenient speed, to prevent their taking wing again. If they settle on a small branch of a tree, easy to come at, it may be cut off and laid upon a cloth, the hive being ready immediately to put over them. If the branch cannot be conveniently cut the bees may be swept from off it into the hive. Lodge but the queen into the hive and the rest will soon follow. If the bees must be considerably disturbed in order to get them into a hive, the most advisable way is to let them remain in the place where they have pitched till the evening, when there is less danger of their taking wing. If it be observed that they still hover about the tree that they first alighted upon, the branches may be rubbed with rue, elder leaves, or any other thing distasteful to them, to prevent their returning to it. The hive employed on this occasion should be cleaned with the utmost care, and its inside rubbed with fragrant herbs or flowers, the smell of which is agreeable to the bees, or with honey. The hive should not be immediately set on the stool where it is to remain, but kept near the place at which the bees settled till the evening, lest some stragglers should be lost. It should be shaded either with boughs or with cloth, that the too great heat of the sun may not annoy the bees. We sometimes see a swarm of bees after having left their hive, and even alighted upon a tree, return to their first abode: this never happens but when the young queen did not come forth with them, for want of strength, or perhaps courage to trust to her wings for the first time, or possibly from a consciousness of her not being impregnated.

When a swarm is too few in number for a hive another may be added. The usual method of thus uniting swarms is very easy; spread a cloth at night upon the ground close to the hive in which the two casts or swarms are to be united, lay a stick across this cloth, then fetch the hive with the new swarm, set it over the stick, give a smart stroke on the top of the hive, and all the bees will drop down upon the cloth in a cluster; this done, throw aside the empty hive, take the other from off the stool and set this last over the bees, who will soon ascend into it, mix with those already there, and become one and the same family. Others, instead of striking the bees down upon the cloth, place with its bottom upmost the hive in which the united swarms are to live, and strike the bees of the other hive down into it. The former of these hives is then restored to its natural situation, and the bees of both hives soon unite. If some bees still adhere to the other hive they may be brushed off on the cloth, and they will soon join their brethren. Or we may take the following method, which gives less disturbance to the bees; set, with its mouth upmost, the hive into which the young swarm has been put, and set upon it the other hive. The bees in the other hive finding themselves in an inverted situation, will soon ascend into the upper. A large

swarm may weigh 8*lb.* and so gradually less to 1*lb.*: consequently a very good one may weigh 5 or 6*lb.* All such as weigh less than 4*lb.* should be strengthened by uniting to each of them a less numerous swarm.

Providence has ordained that insects which feed on leaves, flowers, and green succulent plants, are in an insensible or torpid state, from the time that the winter's cold has deprived them of the means of subsistance: thus the bees, during the winter, are in so lethargic a state, that little food supports them; but as the weather is very changeable, and every warm or sunny day revives them, and prompts them to return to exercise, food becomes necessary on these occasions.

Many hives of bees which are thought to die of cold in winter, in truth die of famine, when a rainy summer has hindered the bees from laying in a sufficient store of provisions. The hives should therefore be carefully examined in autumn, and should then weigh at least 18 pounds. The common practice is, to feed them in autumn, giving them as much honey as will bring the whole weight of the hive to near 20 pounds. The easiest and most rational method is, to set under the hive a plate of liquid honey, with a paper pierced full of holes, through which the bees will suck the honey without daubing themselves. In case honey cannot be procured, a mixture of brown sugar, wetted with strong beer, will answer every purpose. Another circumstance which may render it very necessary to feed the bees is, when several days of bad weather ensue immediately after they have swarmed; for then, being destitute of every supply beyond what they carried with them, they may be in great danger of starving. In this case, honey should be given them in proportion to the duration of the bad weather. In this country it is usual, in seizing the stores of these little animals, to rob them also of their lives. The common method is, that when those which are doomed for slaughter have been marked out, (which is generally done in September), a hole is dug near the hive, and a stick, at the end of which is a rag that has been dipped in melted brimstone, being stuck in that hole, the rag is set on fire, the hive is immediately set over it, and the earth is instantly thrown up all around, so that none of the smoke can escape. In a quarter of an hour all the bees are seemingly dead, and they are rendered soon after irrecoverably so, by being buried in the earth that is returned back into the hole. By this last means it is that they are absolutely killed; for it has been found by experiment, that all the bees which have been affected only by the fume of the brimstone, recover again, excepting such as have been singed or hurt by the flame. Hence it is evident, that the fume of brimstone might be used for intoxicating the bees, with some few precautions. The heaviest and the lightest hives are alike treated in this manner; the former, because they yield the most profit, with an immediate return; and the latter, because they would not be able to survive the winter. Those hives, which weigh from 15 to 20 pounds, are thought to be the fittest for keeping. Various methods have also been adopted in England, to attain the desirable end of getting the honey and wax without destroying the bees; the most approved of which is Mr. Thorley's, who, in his "Inquiry into the Nature, Order, and Government of Bees," thinks colonies preferable to hives. He tells us, thas he has in some summers taken two boxes filled with honey from one colony, and yet sufficient store has been left for their maintenance during the winter, each box weighing 40 pounds. His boxes are made of deal, and an octagon, being nearer to a sphere, is better than a square form; for as the bees, in winter, lie in a round body near the centre of the hive, a due heat is then conveyed to all the outparts. The dimensions which Mr. Thorley, after many years experience, recommends for the boxes, are 10 inches in depth, and 12 or 14 inches in breadth in the inside.

The best and purest honey is that which is gathered in the first five or six weeks: and in boxes of less dimensions, we may take within a month, provided the season be favourable, a boxful of the finest honey. The top of the box should be made of an entire board, a full inch thick after it has been planed, and it should project on all sides, at least an inch beyond the dimensions of the box. In the middle of this top there must be a hole five inches square, for a communication between the boxes; this hole should be covered with a sliding shutter, of deal or elm, running easily in a groove over the back window. The eight pannels, nine inches deep, and three quarters of an inch thick when planed, are to be let into the top so far as to keep them in their proper places, to be secured at the corners with plates of brass, and to be cramped with wires at the bottom to keep them firm; for the heat in summer will try

their strength. There should be a glass window behind fixed in a frame, with a thin deal cover, two small brass hinges, and a button to fasten it. This window will be sufficient for inspecting the progress of the bees. Two brass handles, one on each side, are necessary to lift up the box; these should be fixed in with two thin plates of iron, near three inches long, so as to turn up and down, and put three inches below the top board, which is nailed close down with sprigs to the other parts of the box. Those who choose a frame within, to which the bees may fasten their combs, need only use a couple of deal sticks of an inch square, placed across the box. One thing more, which perfects the work, is a passage four or five inches long, and less than half an inch deep, for the bees to go in and out at the bottom of the box. In keeping bees in colonies, a house is necessary, or at least a shade; without which the weather, especially the heat of the sun, would soon rend the boxes to pieces. The house may be made of any boards, but deal is the best; and it must be painted, to secure it from the weather. The length of it for six colonies, should be full twelve and a half feet, and each colony should stand a foot distant from the other. It should be three and a half feet high, to admit four boxes one upon another; but if only three boxes are employed, two feet eight inches will be sufficient. Its breadth in the inside should be two feet. The best time to plant the colonies is, either in spring with new stocks full of bees, or in summer with swarms. If swarms are used, procure if possible two of the same day; hive them either in two boxes, or in a hive and a box; at night place them in the bee-house, one over the other, and with a knife and a little lime and hair, stop close the mouth of the hive or upper box, so that not a bee may be able to go in or out but at the front door. Within a week or ten days the combs will appear in the boxes; but if it be a hive, nothing can be seen till the bees have wrought down into the box. Never plant a colony with a single swarm. When the second box, or the box under the hive, appears full of bees and combs, it is time to raise the colony. This should be done in the dusk of the evening, and in the following manner.

Place the empty box, with the sliding shutter drawn back, behind the house, near the colony that is to be raised, and at nearly the height of the floor: then lifting up the colony as quickly as possible, let the empty box be put into the place where it is to stand, and the colony upon it; and shut up the mouth of the then upper box with lime and hair, as directed before. When upon looking through the windows in the back of the boxes, the middle box appears full of combs, and a quantity of honey sealed up in it, the lowest box half full of combs, and few bees in the uppermost box, proceed thus: About five o'clock in the evening, drive close with a mallet the sliding shutter under the hive or box that is to be taken from the colony. If the combs are new, the shutter may be forced home without a mallet; but be sure it is close, that no bees may ascend into the hive or box to be removed. After this, shut close the doors of the house, and leave the bees thus cut off from the rest of their companions, for half an hour or more. In this space, having lost their queen, they will fill themselves with honey, and be impatient to be set at liberty. If, in this interval, upon examining the box or boxes beneath, all appears to be quiet in them, it is a sign that the queen is there, and in safety. Afterwards raise the back part of the hive or box so far, by a piece of wood slipped under it, as to give the prisoners room to come out, and they will return to their fellows: then lifting the box from off the colony, and turning its bottom upmost, cover it with a cloth all night; and the next morning, when this cloth is removed, the bees that have remained in it will return to the colony. Thus a box of honey is procured, and all the bees are preserved.

Bees have various enemies; mice should be guarded against, by diminishing the entrance into the hives when the cold comes on, and the bees are less able to defend themselves; and the hives may be placed in such a manner, that it will be impossible for the mice to reach them. Spiders and caterpillars are very destructive to bees; a species of the latter, called the wax-worm, or wax-moth, because it feeds on wax, lays its eggs in the hive, which turn to maggots that are very noisome and prejudicial. Hives of bees that have swarmed more than once, and such as contain little honey, are most exposed to these insects; for the empty combs serve them for shelter, and the wax supplies them with food. These hives should be cleaned at least once a week; and the stools on which they rest, where the moths are laid by the bees, should be cleaned every morning. But they cannot be entirely destroyed, without

taking away the infected hive, removing the bees, and cleansing it of the moths, before it is restored to its former occupiers. Bees are often troubled with lice, which may be destroyed by strewing tobacco over them. The depredations of birds, and particularly of the house-lark and swallow, should be carefully prevented. Ants, woodlice, and earwigs, are also enumerated among the enemies of the bees. Mr. Keys says, "the earwigs steal into the hives at night, and drag out bee after bee, sucking out their vitals, and leaving nothing but their skins or scalps like so many trophies of their butchery." Wasps and hornets are, however, the most formidable enemies that bees have to encounter. See Apiary and Apis.

BEECH. See Fagus.

BEER, a fermented liquor, made generally from some farinaceous grain, particularly from prepared barley or malt. The mode of making beer will be found under the article Brewing. It may be observed, that during the scarcity of grain in this country, sugar, treacle, and melasses were frequently used as a substitute for malt. We shall in this place describe a machine that has obtained pretty general use in the public-houses in and near the metropolis, *viz.* the

Beer *pump.* The Plate explains the construction of a set of beer pumps, as made by Mr. Thomas Rowntree, engine-maker, Blackfriars road: the pumps are not of the common construction; but similar to that made use of in his extinguishing engine: they are double, and throw out the liquor at either motion of the handle. Figures 4 and 5 are two sections of a pump at right angles to each other: fig. 4 being a section through the dotted line A B, fig. 5: and fig. 5 a section through C D, fig. 4: the same letters are used in both figures E E: FF is a brass cylinder with a flanch, E E (dotted in fig. 5) in front: G G, fig. 4, is a cover screwed to the cylinder with a stuffing-box *n* in the centre, to receive the spindle H: I is a partition in the cylinder, with a packing at *a*, to embrace the spindle, and make a tight joint, this has two valves, *b*, *d*, shutting downwards upon holes made in the partition: K is the suction pipe, bringing liquor to the lower division of the cylinder, but has no other communication with the upper, but the two valves *b*, *d*: L is the piston fixed to the spindle, and fitting the cylinder tight all round, so as to divide the upper part into two other parts: *e*, *f*, are copper pipes to convey the liquor from the upper half of the cylinder, to a chamber N, and its return is prevented by valves *g*, *h*, on the ends of the pipes: O is the forcing pipe screwed to the chamber N: when the piston is moved by the handles on the end of its spindle toward *b*; for instance, the valve *b* will be shut, and the liquor on that side finding no other passage, passes through the pipe *e*, and valve *g*, and into the chamber N, and is conveyed by means of the force-pipe O, where required: the same motion of the piston, enlarging the space on the side *d*, shut the valve *h* at the end of the pipe *f*, and formed a vacuum: the pressure of the atmosphere upon the surface of the liquor, in which the end of K is immersed, forces it through the pipes, opens the valve *d*, and restores the equilibrium. The operation is exactly the same when the piston is moved in the other direction from L to *d*: the liquor going to O through *f*, and coming from K through *b*. Three of these pumps are mounted in a frame, as shewn in figures 1 and 2, which is inclosed in a box, with a circular top A B, and the handles *a*, *b*, *c*, project through it: the suction-pipes *d*, *e*, *f*, go through the floor into the cellar below: the force-pipes from the top of the pumps are bent, and come through the side of the box where the pots are held to be filled: *h* is a small cistern to receive the waste, which is conveyed by a pipe to a waste butt in the cellar: the suction-pipes pass through the floor, and are carried along the ceiling until just over the butt; they are then bent down, and jointed to the cock drove into the butt in the usual manner: the pipes are of lead, half an inch bore, and very thin, so that they can be bent (without breaking) to reach any particular place; they are connected with the cock by a screw joint, shewn in fig. 3: A B is the brass cock; its outer end B cut into screw, and the bore enlarged to form a socket for a short brass pipe D, soldered to the leaden one: a piece of leather put between the end of the cock and the shoulder of D makes a tight joint: these are kept together by a collar E, embracing the shoulder of D, and screwing upon the end of the cock: *e* is a stub projecting from it, by which it is turned. The piston of the pump consists of 3 plates, figures 4 and 5: the middle one, (which should be called the piston) is cast in a piece with the spindle, and fits the cylinder as true as possible without touching; then square pieces of leather are put on each side of the piston, to form the joint, and a thin plate of metal put on over the leathers,

and screwed to the piston, (as shewn at L, fig. 4,) holds it all fast. The body of the piston, as we have said before, fits the cylinder as close as possible: the leathers are about half an inch bigger all round, so that when they are put into the cylinder, their edges will turn up all round, and form a dish, and its elasticity, pressing against the cylinder, prevents any of the liquor getting through; the two outside plates must be the thickness of the leather less all round than the cylinder, and their use is to keep the edges of the leather up against the cylinder, and to hold the four screws by which the leather is fastened. The back of the spindle opposite the piston must have a packing of hemp drove into the space *a* behind it, to make all tight, and the metal edges of the partition I, should fit it as closely as possible to work free: the valves are pieces of leather fastened at one side of the hole, and a piece of brass is rivetted to them to make them heavy enough to fall, and prevent the leather bending by the pressure of the column of liquor: the top of the cylinder at N is filed flat, and the chamber, which is a square prism, placed on it with leather between, and the lid is put on the upper part, and all screwed together by four long screws going through the lid, and the corners of the chamber, and tapped into the cylinder below. When these valves want repairing, the four screws are taken out, and the lid can then be removed. To come at the valves *b*, *d*, the cylinder lid GG can be removed, by taking out five screws: the lid has a hole turned in its centre, which fits the spindle H as close as possible: the hole afterwards enlarges, and has a piece of leather (represented by the dark part, fig. 4,) bent into a cup, so as to embrace the spindle: the leather is kept in his place by a perforated screw *n*, tapped into a projecting part of the lid, and pressing on the leather, the suction pipe K of the pump is joined to the leaden pipes by a screw joint K, so that it can be separated occasionally to remove the pump from the frame.

BEESTINGS, a term used by country-people for the first milk taken from a cow after calving.

BEET. See BETA.

BEETLE. See SCARABÆUS.

BEETLE also denotes a wooden instrument for driving piles, &c.

It is likewise called a stamper, and by paviors a rammer.

BEGGAR, one who begs alms.

Beggars pretending to be blind, lame, &c. found begging in the streets, are to be removed by constables; and if they refuse to be so removed, shall be publicly whipt.

BEGONIA, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Holoracæ. Incertæ, Jussieu. Essential character: male calyx none; corolla many-petalled, stamens numerous. Female calyx none; corolla many-petalled, superior; capsule winged, many-seeded. There are 23 species. The whole plant in the Begonias is fleshy. The stem in most of the species is herbaceous; but some of them are stemless. They are natives of Asia and America, within the Tropics. Three species have been found on the islands near the coast of Africa, but none on that continent.

BEHMENISTS, in church history, a sect of Christians, who derive their name from Jacob Behmen, a German mystic and enthusiast, whose distinguishing tenets were, that man has the immortal spark of life which is common to angels and devils; that divine life of the light and spirit of God makes the difference between an angel and devil, the latter having distinguished this divine life in himself; but that man can only attain to the heavenly life of the second principle through the new birth of Jesus Christ: that the life of the third principle is of the external and visible world. Thus, the life of the first and third principles is common to all men, but the life of the second principle only to a true Christian or child of God. Behmen was a pious man, and his principles were adopted by our countryman William Law, a worthy divine of the church of England; but in general, to a by-stander, the Behmenites seem to try how they can talk on religion so as not to be intelligible.

BEJARIA, in botany, so called in honour of a Spanish botanist, a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes; Rhododendra, Jussieu. Essential character, calyx seven-cleft; petals seven; stamina fourteen; berry seven-celled, many-seeded. There are two species found in New Granada.

BEING, in metaphysics, includes not only whatsoever actually is, but whatsoever can be. The various kinds of beings have been referred into three distinct classes, and they have been considered as either substances or modes, finite or infinite, and natural, artificial, or moral. Natural beings are all those things that have a real and

Rowntree's Beer Engine.

Fig. 1.

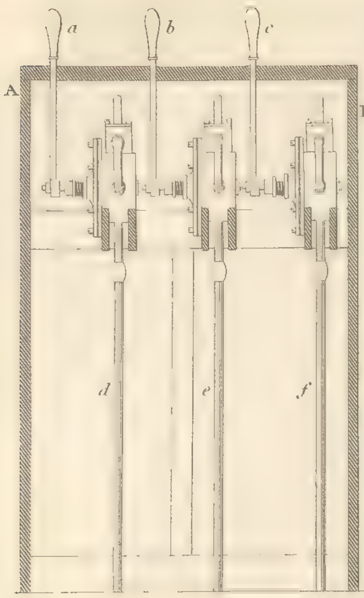


Fig. 2.

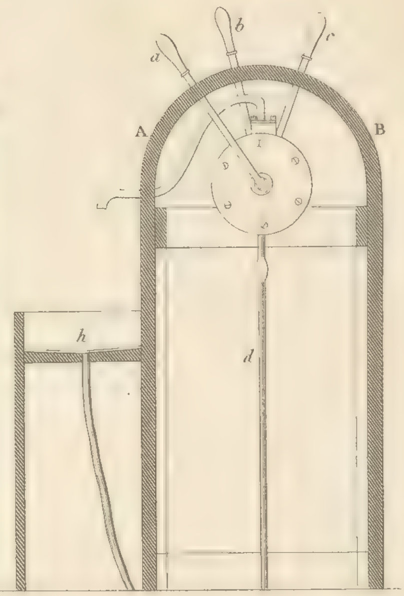


Fig. 3.

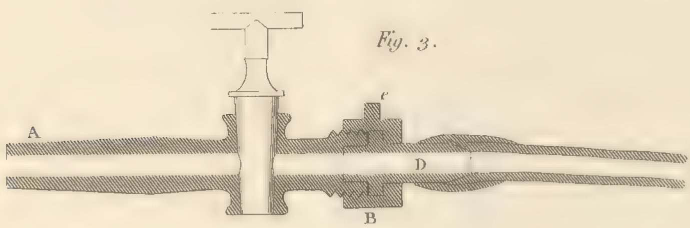


Fig. 4.

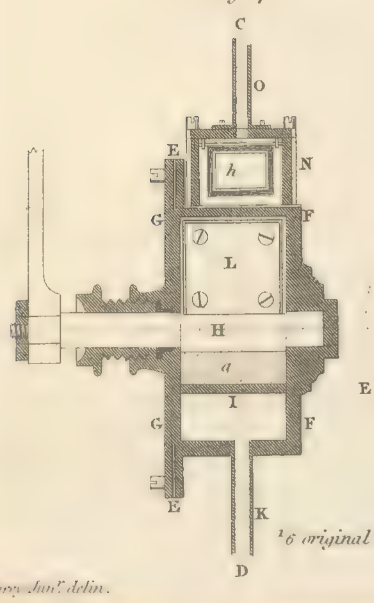


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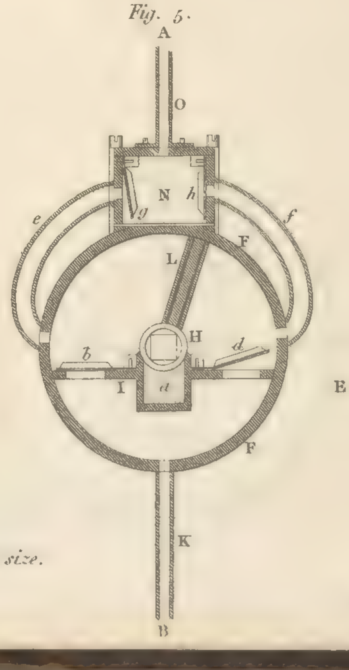
Fig. 5.



J. Farey Jun.r delin.

Lowry sculp.

proper existence in the universe, and are considered as formed and ordained by God the Creator; such are men, beasts, trees, &c. Artificial beings are made by the contrivance or operations of men, whether they are of a more corporeal nature, such as houses, statues, &c. or whether they relate to intellectual matters, as words, sciences, verse, &c. Moral beings are those which belong to the conduct and government of intelligent creatures, or creatures endowed with understanding and volition, considered as lying under obligations to particular actions.

BELL, a well-known machine, ranked by musicians among the musical instruments of percussion.

The metal is usually composed of three parts of copper and one part of tin. Its colour is greyish white; it is very hard, sonorous, and elastic. The greater part of the tin may be separated by melting the alloy, and then pouring a little water on it. The tin decomposes the water, is oxidised, and thrown upon the surface. According to Swedenburg, the English bell-metal is usually made from the scoriæ of the brass gun foundry, melted over again. The proportion of tin in bell-metal varies. Less tin is used for church bells than clock bells; and in small bells, as those of watches, a little zinc is added to the alloy. According to Gerbert, the conch of the East Indians is composed of tin and copper, in the same proportions as in bell-metal.

The constituent parts of a bell are the body or barrel, the clapper on the inside, and the ear or cannon on which it hangs to a large beam of wood.

The sound of a bell consists in a vibratory motion of its parts, much like that of a musical chord. The stroke of the clapper must necessarily change the figure of the bell, and of a round make it oval; but the metal having a great degree of elasticity, that part will return back again which the stroke drove farthest off from the centre, and that even some small matter nearer the centre than before; so that the two parts which before were extremes of the longest diameter, do then become those of the shortest; and thus the external surface of the bell undergoes alternate changes of figure, and by that means gives that tremulous motion to the air, in which the sound consists.

M. Perrault asserts, that the sound of the same bell is a compound of the sound of the several parts of it; so that where the parts are homogeneous, and the dimensions of the figure uniform, there is such a perfect mixture of all these sounds, as constitutes one uniform, smooth, even sound, and the contrary circumstances produce harshness. To confirm this, he observes the different tone of the bell, according to the part of it that is struck; and yet strike it where you will, there is a motion of all the parts. He therefore considers bells as composed of an infinite number of rings, which have different tones according to their different dimensions, as chords of different lengths have; which, when struck, the vibrations of the parts immediately struck determine the tone; being supported by a sufficient number of consonant tones in other parts.

It has been found by experience, that bells are heard further, if placed on plains, than on hills, and still farther in vallies than on plains; the reason of which may be easily comprehended, by considering, that the higher the sonorous body is, the medium is the rarer, and consequently receives the less impulse, and the vehicle is the less proper to convey it to a distance.

The bell-founders distinguish two sorts of proportions, *viz.* the simple and the relative. The simple proportions are those which ought to be between the several parts of a bell, and which experience has shewn to be necessary towards rendering it sweetly sonorous. The relative proportions are those which establish a requisite relation between one bell and another, so that their combined sounds may affect a certain determined harmony.

The use of bells is very ancient, as well as extensive. We find them among the Jews, Greeks, Romans, Christians, and Heathens, variously applied, as on the necks of men, beasts, birds, horses, sheep; but chiefly hung in buildings, either religious, as in churches, temples, and monasteries; or civil, as in houses, markets, baths; or military, as in camps and frontier towns.

When they were first invented, or who introduced them into the Christian church, is not at present known: but it appears that they were employed in the eastern church in the ninth century, when Ursus Patriciacus, Duke of Venice, made a present of a set to Michael, the Greek emperor, who built a tower to the church of Sancta Sophia, in which to hang them.

BELLARDIA, in botany, a genus of the Tetrandia Monogynia class and order: calyx four-cleft superior; nectary with a

four-lobed margin surrounding the style; capsule two-celled, many-seeded. One species, found at Cayenne.

BELLES *lettres*, generally considered as synonymous with polite literature; they include the origin and structure of the various kinds of language; of grammar, universal and particular, criticism, rhetoric; history in its several departments, and all the different kinds of poetry. Different authors have included different departments of literature under this general term. The reader may be referred to Blair's Lectures, as including almost every thing that is necessary for a student to be informed of on the subject. See CRITICISM, GRAMMAR, POETRY, RHETORIC, &c.

BELLIS, in botany, *common daisy*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ; Jussieu. Essential character, calyx hemispheric, with equal scales; seeds ovate, with no down; receptacle naked, conical. There are only two species, with many varieties; *viz.* B. perennis, or common daisy, is sufficiently distinguished by its perennial root, is a native of most parts of Europe in pastures; flowers almost all the year, and shuts up close every night, and in wet weather. The taste of the leaves is somewhat acrid: in some countries, however, it is used as a pot-herb. The roots have a penetrating pungency. It is ungrateful to cattle, and even to geese; it occupies therefore a large share of pasture lands, to the exclusion of grass and profitable herbs. B. annua is a low plant, seldom rising more than three inches high, with an upright stalk, having leaves on the lower part, but the upper part naked, and supporting a single flower like that of the common daisy, though smaller. Native of Sicily, Spain, about Montpellier, Verona, and Nice.

BELLIUM, in botany, a genus of the Syngenisia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character, calyx with equal leaflets; seeds conic, with a chaffy eight-leaved crown, and awned down; receptacle naked. There are only two species, *viz.* B. bellidioides, has the habit of the daisy, though it differs essentially from it in having a down to the seed. Native of Italy about Rome, and in the island of Majorca. B. minutum, is one of the smallest of plants. This plant, examined with a glass, appears to have hairs scattered over it. Native of the Levant.

BELLONIA, in botany, so named in honour of Pierre Belon, a famous French physician, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character, corolla wheel-shaped; capsule one-celled, inferior, many-seeded, beaked with the calyx. There are but two species, *viz.* B. aspera, is a shrub ten or twelve feet in height, sending out many lateral branches; flowers in loose corymbs. This species is yet little known, and, according to Swartz, has been seen only by Plumier. It is very common in several warm islands in America.

BELLOWS, a machine so contrived as to agitate the air with great briskness, expiring and inspiring it by turns, and that only from enlarging and contracting its capacity.

This machine is used in chambers and kitchens, in forges, furnaces, and founderies, to blow up the fire; it serves also for organs and other pneumatic instruments, to give them a proper degree of air. All these are of various constructions, according to their different purposes, but in general they are composed of two flat boards, sometimes of an oval, sometimes of a triangular figure. Two or more hoops, bent according to the figure of the boards, are placed between them; a piece of leather, broad in the middle, and narrow at both ends, is nailed on the edges of the boards, which it thus unites together: as also on the hoops which separate the boards, that the leather may the easier open and fold again; a tube of iron, brass, or copper is fastened to the undermost board, and there is a valve within that covers the holes in the underboard, to keep in the air.

The action and effect of bellows of every kind, whether constructed with leather or wood, wrought by men, by steam, or by water, depends on this, that the air which enters them, and which they contain when raised, is again compressed into a narrower space when they are closed. As the air flows to that place where it meets with the least resistance, it must of necessity fly out of the pipe with a velocity proportional to the force by which it is compressed, and must therefore blow stronger or weaker, as the velocity with which the top and bottom of the bellows meet is greater or less. The blast will last in proportion to the quantity of air that was drawn into the bellows through the valve. The action of the bellows bears a near affinity to that of the lungs, and what is called blowing in the

latter, affords an illustration of what is called respiring in the former: hence bellows have been employed in restoring suspended animation. See DROWNING.

The bellows of smiths, founders, &c. are worked by means of a rocker, with a string fastened to it, and pulled by the workman. One of the boards is fixed so as not to play at all. By drawing down the handle of the rocker, the moveable board rises, and by means of a weight on the top of the upper board sinks again. Large bellows used in founderies, &c. receive their motion from water wheels or steam: others that are small are worked by the feet of the men using them, as is the case with enamellers, jewellers, &c. The bellows of an organ are six feet long, and four feet broad, each having an aperture of four inches, that the valve may play easily. To blow an organ of sixteen feet, there are required four pair of these bellows.

BELLUÆ, in natural history, the sixth order of the class Mammalia. They are distinguished by fore-teeth, obtuse; feet hoofed; motion heavy; food gathering vegetables. There are four genera, *viz.*

Equus.	Sus.
Hippopotamus.	Tapir.

BELLY, in anatomy, the same with what is more usually called abdomen, or rather the cavity of the abdomen. See ANATOMY.

BELLY *of an instrument*, in music, is that thin, smooth board over which the strings in a harpsichord, piano-forte, &c. are distended, and which by the vibration contributes to the tone. In a violin, and other instruments performed with a bow, and in a guitar, it is that part of the body which lies immediately under the strings.

BELT, in the military art, a leathern girdle for sustaining the arms, &c. of a soldier.

BELTS, in astronomy, zones or girdles surrounding the planet Jupiter, brighter than the rest of his body, and terminated by parallel lines. They are observed, however, to be sometimes broader and sometimes narrower, and not always occupying exactly the same part of the disc. Jupiter's belts were first observed and described by Huygens. Dark spots have often been observed on the belts of Jupiter; and M. Cassini observed a permanent one on the northern side of the most southern belt, by which he determined the length of Jupiter's days, or the time in which the planet revolves upon its axis, which is $9^h\ 56^m$. Some astronomers suppose that these belts are seas, which alternately cover and leave bare large tracts of the planet's surface: and that the spots are gulphs in those seas, which are sometimes dry, and sometimes full. But Azout conceived that the spots are protuberances of the belts; and others again are of opinion that the transparent and moveable spots are the shadows of Jupiter's satellites.

Cassini also speaks of the belts of Saturn; being three dark, straight parallel bands, or *fasciæ*, on the disc of that planet. But it does not appear that Saturn's belts adhere to his body, as those of Jupiter do; but rather that they are large dark rings surrounding the planet at a distance. Some imagine that they are clouds in the atmosphere of Saturn, though it would seem that the middlemost is the shadow of his ring.

BELTS, in geography, certain straights between the German ocean and the Baltic. The belts belong to the King of Denmark, who exacts a toll from all ships which pass through them, excepting those of Sweden, which are exempted.

BELVIDERE, in the Italian architecture, &c. denotes either a pavilion on the top of a building, or an artificial eminence in a garden: the word literally signifying a fine prospect.

BEND, in heraldry, one of the nine honourable ordinaries, containing a third part of the field when charged, and a fifth when plain. It is sometimes, like other ordinaries, indented, ingrailed, &c. and is either dexter or sinister.

BEND *dexter* is formed by two lines drawn from the upper part of the shield on the right to the lower part of the left, diagonally. It is supposed to represent a shoulder belt, or a scarf, when worn over the shoulder.

BEND *sinister* is that which comes from the left side of the shield to the right: this the French heralds call a barre.

BEND *in* is when any things borne in arms are placed obliquely from the upper corner to the opposite lower, as the bend lies.

BENDING, in a general sense, the reducing a straight body into a curve, or giving it a crooked form.

The bending of timber, boards, &c. is effected by means of heat or steam, whereby their fibres are so relaxed that you may bend them into any figure.

BENDING, in the sea-language, the tying two ropes or cables together: thus they say, bend the cable, that is, make it fast to the

ring of the anchor; bend the sail, make it fast to the yard.

BENDS, in a ship, the same with what is called wails, or wales; the outmost timbers of a ship's side, on which men set their feet in climbing up. They are reckoned from the water, and are called the first, second, or third bend. They are the chief strength of a ship's sides, and have the beams, knees, and foot-hooks bolted to them.

BENDY, in heraldry, is the field divided into four, six, or more parts, diagonally, and varying in metal and colour.

The general custom of England is to make an even number, but in other countries they regard it not, whether even or odd.

BENEFICE is generally taken for all ecclesiastical livings, be they dignities or not: all church preferments are benefices; but they must be given for life, and not for a term of years or at will.

BENEFIT *of clergy.* By stat. 3, Ed. I. c. 3, it is enacted, that for the scarcity of clergy in the realm of England, to be disposed of in religious houses, or for priests, deacons, and clerks of parishes, there should be a prerogative allowed to the clergy, that if any man that could read as a clerk were to be condemned to death, the bishop of the diocese might, if he would, claim him as a clerk; and he was to see him tried in the face of the court if he could read or not; if the prisoner could read, then he was to be delivered over to the bishop, who should dispose of him in some places of the clergy as he should think meet; but if either the bishop would not demand him, or the prisoner could not read, then he was to be put to death.

By the common law a woman was not entitled to the benefit of clergy; but by 3 W. c. 9, s. 6, a woman convicted, or outlawed, for any felony for which a man might have his clergy, shall, upon her prayer to have the benefit of this statute, be subject only to such punishment as a man would in a like case.

But every person (not being within orders,) who has been once admitted to his clergy, shall not be admitted to it a second time, 4 Hen. VII. c. 13; and against the defendant's plea of clergy the prosecutor may file a counter plea, alleging some fact, which in law deprives the defendant of the privilege he claims; as, he was before convicted of an offence, and therefore not entitled to the benefit of the statute.

In case of high treason against the king, clergy was never allowable.

When a person is admitted to his clergy, he forfeits all the goods he possessed at the time of the conviction. 2 H. H. 388. But immediately on his burning in the hand, he ought to be restored to the possession of his lands, 2 H. H. 388. It also restores him to his credit, and consequently enables him to be a good witness.

BENEVOLENCE is used in the statutes of this realm for a voluntary gratuity given by the subjects to the king. This, instead of a gift, is an extortion and imposition, that has been guarded against by the declaration of rights, 1 Wm. 2 st. where it is insisted, that levying money for or to the use of the crown, by pretence of prerogative, without grant of parliament is illegal.

BENZOATS, salts formed of the benzoic acid and alkalies and most of the earths. They are all soluble, and from them the acid may be separated by means of the muriatic acid. Many of the metallic oxides are soluble in this acid, but not the metals themselves. The benzoat of lime has been found in the urine of horses and some other quadrupeds: and from this is ascribed the sub-aromatic smell sometimes perceived from the liquid when fresh. The benzoats in chemical affinity follow this order:

Lime	Soda
Barytes	Ammonia
Magnesia	Alumina
Potash	Metallic oxides

BENZOIN, in chemistry, a gum called gum Benjamin; is brought from the East Indies in brittle masses of unequal degrees of purity, and varying in colour from yellow to white. It has but little taste; but if previously dissolved it is rather pungent and aromatic. Its smell is grateful when rubbed or warmed, and when the heat is increased the resin melts, a white and most fragrant vapour rises, which is easily condensed on the surrounding bodies into beautiful shining saline needles. These are what are denominated benzoic acid. Benzoin is very soluble in alcohol, but separates on the addition of water. It is one of the most important balsams in modern chemistry, which are considered as resins naturally united with that volatile chrystalizable acid which has just been mentioned, and which is the same in all natural balsams. The benzoic acid may be prepared either by sublimation or by digestion: that obtained by sublimation is remarkably light, feathery, and elastic. When pure it is quite white; for the

yellowness is owing to its admixture with oil. This acid is contained in styrax and balsam of Tolu, giving them the characters of true balsams. It is likewise met with, but more sparingly, in several fragrant barks, resins, and other vegetable matters. It generally appears in its proper character when these substances are moderately heated; or it may be extracted with lime. Benzoic acid, or, as it is called in the shops, flowers of Benjamin, is the chief ingredient of the celebrated "pomade divine," of which, according to Dr. Beddoes, the composition is as follows:

Beef marrow...	*oz.* 12	steeped in water ten days, and afterwards in rose-water 24 hours.
Flowers of Benjamin.......... Pounded storax Florentine orris		of each ½ an ounce.
Cinnamon.......		¼ ounce.
Clove & nutmeg		¼ ditto.

The whole to be put in an earthen vessel, closely covered down to keep in the fumes, and being suspended in water made to boil three hours. After which the whole is to be strained and put in bottles.

BERBERIS, *barberry*, in botany, a genus of the Hexandria Monogynia class and order. Essential character: calyx six-leaved; petals six, with two glands at the claws; style none; berry two-seeded. There are four species, of which B. vulgaris, is a shrub rising to the height of eight or ten feet. It is a native of eastern countries, and found in most parts of Europe, in woods, coppices, and hedges. In England, chiefly in a chalky soil, as particularly about Saffron Walden in Essex. The leaves of this shrub are gratefully acid. The smell of the flowers is offensive when near, but pleasant at a certain distance. The berries are so very acid that birds seldom touch them. They are pickled, and used for garnishing dishes; and being boiled with sugar, form a most agreeable jelly. The roots boiled in lye yield a yellow colour; and in Poland they dye leather of a fine yellow with the bark of the root. The inner bark of the stems also will dye linen of a fine yellow with the assistance of alum. Insects of various kinds are remarkably fond of the flowers of barberry. Linnæus observed long since, that when bees in search of honey touch the filaments, the anthers approximate to the stigma, and explode the pollen. Dr. Smith has given the following particular account of this curious phenomenon. The stamens of such flowers as are open bend back to each petal, and shelter themselves under their concave tips. No shaking of the branch has any effect upon them; but if the inside of the filaments be touched with a small stick, they instantly spring from the petal, and strike the anther against the stigma. The outside of the filament has no irritability, nor has the anther itself any; as may easily be proved by touching either of them with a blunt needle, a fine bristle, a feather, or any thing which cannot injure the structure of the part. If a stamen be bent to the stigma, by means of a pair of scissars applied to the anther, no contraction of the filament is produced. From all this it is evident, that the spring of the stamens is owing to an high degree of irritability in the side of the filament next the germ, by which, when touched, it contracts, that side becomes shorter than the other, and consequently the filament is bent towards the germ. This irritability is perceptable in all ages; in flowers only so far expanded as to admit a bristle; and in old flowers ready to fall off. If the germ be cut off, the filaments will still contract, and nothing being in their way, will bend over quite to the opposite side of the flower. After irritation, the stamens will return to their original place. On being touched, they will contract with the same facility as before; and this may be repeated three or four times. The purpose which this contrivance of nature answers is evident. In the original position of the stamens the anthers are sheltered from rain by the concavity of the petals. Thus probably they remain, till some insect coming to extract honey from the base of the flower, thrusts itself between the filaments, and almost unavoidably touches them in the most irritable part: thus the impregnation of the germ is performed; and as it is chiefly in fine sunny weather that insects are on the wing, the pollen is also in such weather most fit for the purpose of impregnation.

BERCKHEYA, in botany, a genus of the Syngenesia Frustranea class and order. Receptacle chaffy; seeds hairy, crowned with chaff; calyx imbricate; florets of the ray hermaphrodite, with the stamina castrate. There are more than 20 species natives of the Cape.

BEREANS, in church history, a sect of Christians who profess to follow the example of the ancient Bereans, in building their faith and practice upon the scriptures alone, without regard to any human authority

whatever. The founder of this sect was Mr. Barclay, a Scotch clergyman.

BERGAMOT, the name of a fragrant essence extracted from a fruit which is produced by ingrafting a branch of a lemon-tree upon the stock of a bergamot-pear.

BERGERA, in botany, so named from Berger, professor of Kiel, a genus of the Decandria Monogynia class and order. Essential character: calyx five-parted; petals five; berry sub-globular, one-celled, with two seeds. There is but one species; *viz.* B. koenigii. This is a very leafy tree, with the bark of alder. It is a native of the East Indies.

BERGIA, in botany, from Peter Jonas Bergius, professor of natural history at Stockholm, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Caryophylleæ, Juss. Essential characters: calyx five-parted; petals five; capsule one, globular with swellings, five-celled, five-valved; valves resembling petals: seeds very many. There are two species; *viz.* B. capensis, and B. glomerata: the stem of the former is extremely simple, half a foot high, the thickness of a pigeon's quill, erect, smooth, rather succulent. It is a native of Tranquebar, in the East Indies, and therefore is misnamed capensis. The valves of the capsule continuing after it is ripe, form a kind of fine petalled wheel-shaped flower. The other species is found at the Cape.

BERGSEIFE, in mineralogy, *mountain-soap*, is of a brownish colour, and is found in mass and disseminated. It is dull internally, and its fracture is fine-earthy, passing into flat conchoidal. It is opaque, does not stain the fingers, gives a resinous streak, is very soft, adheres powerfully to the tongue, and is light. It is found in rocks in Poland and Bohemia, where it is used for washing linen, and in the Isle of Skye in Scotland.

BERKELEY (George) the virtuous and learned bishop of Cloyne in Ireland, was born in that kingdom, at Kilcrin, the 12th of March, 1684. After receiving the first part of his education at Kilkenny school, he was admitted a pensioner of Trinity College, Dublin, at 15 years old; and chosen fellow of that college in 1707.

The first public proof he gave of his literary abilities was, "Arithmetica absque Algebra aut Euclide demonstrata;" which, from the preface it appears he wrote before he was 20 years old, though he did not publish it till 1707. It is followed by a mathematical miscellany, containing observations and theorems inscribed to his pupil Samuel Molineux.

In 1709 came out the "Theory of Vision;" which of all his works, it seems, does the greatest honour to his sagacity; being, it has been observed, the first attempt that ever was made to distinguish the immediate and natural objects of sight, from the conclusions we have been accustomed from infancy to draw from them. The boundary is here traced out between the ideas of sight and touch; and it is shewn, that though habit hath so connected these two classes of ideas in the mind, that they are not without a strong effort to be separated from each other, yet originally they have no such connection; insomuch, that a person born blind, and suddenly made to see, would at first be utterly unable to tell how any object that affected his sight would affect his touch; and particularly would not from sight receive any idea of distance, or external space, but would imagine all objects to be in his eye, or rather in his mind.

In 1710 appeared "The Principles of Human Knowledge;" and in 1713 "Dialogues between Hylas and Philonous:" the object of both which pieces is, to prove that the commonly received notion of the existence of matter is false; that sensible material objects, as they are called, are not external to the mind, but exist in it, and are nothing more than impressions made upon it by the immediate act of God, according to certain rules termed laws of nature.

Acuteness of parts and beauty of imagination were so conspicuous in Berkeley's writings, that his reputation was now established, and his company courted; men of opposite parties concurred in recommending him. For Steele he wrote several papers in the Guardian, and at his house became acquainted with Pope, with whom he always lived in friendship. Swift recommended him to the celebrated Earl of Peterborough, who being appointed ambassador to the King of Sicily and the Italian States, took Berkeley with him as chaplain and secretary in 1713, with whom he returned to England the year following.

His hopes of preferment expiring with the fall of Queen Anne's ministry, he some time after embraced an offer made him by Ashe, bishop of Clogher, of accompanying his son in a tour through Europe. In this he employed four years; and besides those places which fall within the grand tour, he visited some that are less frequented, and with great industry collected materials for

a natural history of those parts, but which were unfortunately lost in the passage to Naples. He arrived at London in 1721; and being much affected with the miseries of the nation, occasioned by the South-sea scheme in 1720, he published the same year "An Essay towards preventing the ruin of Great Britain;" reprinted in his "Miscellaneous Tracts."

His way was now open into the first company. Pope introduced him to Lord Burlington, by whom he was recommended to the Duke of Grafton, then appointed Lord Lieutenant of Ireland, who took Berkeley over as one of his chaplains in 1721. The latter part of this year he accumulated the degrees of bachelor and doctor of divinity; and the year following he had a very unexpected increase of fortune from the death of Mrs. Vanhomrigh, the celebrated Vanessa, to whom he had been introduced by Swift. This lady had intended Swift for her heir; but perceiving herself to be slighted by him, she left her fortune of 8,000*l.* between her two executors, of whom Berkeley was one. In 1724 he was promoted to the deanery of Derry, worth 1,100*l.* a year.

In 1732 he published "The Minute Philosopher," in two volumes 8vo., against Freethinkers. In 1733 he was made Bishop of Cloyne; and might have been removed in 1745, by Lord Chesterfield, to Clogher, but declined it. He resided constantly at Cloyne, where he faithfully discharged all the offices of a good bishop, yet continued his studies with unabated attention.

About this time he engaged in a controversy with the mathematicians, which excited much debate in the literary world; and the occasion of it was this: Addison had given the Bishop an account of the behaviour of their common friend Dr. Garth, in his last illness, which was equally unpleasing to both these advocates of revealed religion. For when Addison went to see the Doctor, and began to discourse with him seriously about another world, "Surely, Addison," replied he, "I have good reason not to believe those trifles, since my friend Dr. Halley, who has dealt so much in demonstration, has assured me, that the doctrines of christianity are incomprehensible, and the religion itself an imposture." The Bishop therefore took up arms against Halley, and addressed to him, as to an Infidel mathematician, a discourse called "The Analyst;" with a view of shewing that mysteries in faith were unjustly objected to by mathematicians, who he thought admitted much greater mysteries, and even falshoods in science, of which he endeavoured to prove that the doctrine of fluxions furnished a clear example. This occasioned a long controversy between himself and some eminent mathematicians.

In 1736 Bishop Berkeley published "The Querist," a discourse addressed to magistrates, occasioned by the enormous licence and irreligion of the times; and many other things afterwards of a smaller kind. In 1744 came out his celebrated and curious book, "Siris; a Chain of Philosophical Reflections and Inquiries concerning the virtues of Tar-water." July the same year he removed, with his lady and family, to Oxford, partly to superintend the education of a son, but chiefly to indulge the passion for learned retirement, which had always strongly possessed him. He would have resigned his bishopric for a canonry or headship at Oxford; but it was not permitted him. Here he lived highly respected, and collected and printed the same year all his smaller pieces in 8vo. But this happiness did not long continue, being suddenly cut off by a palsy of the heart, January 14, 1753, in the 69th year of his age, while listening to a sermon that his lady was reading to him. The excellence of Berkeley's moral character is conspicuous in his writings: he was an amiable as well as a very great man; and in many respects worthy the character given him by Pope:

"To Berkeley every virtue under heaven."

BERMILCH, in mineralogy, called the agaric mineral, is yellowish white, and is composed of slightly cohering very fine particles: it is dull, opake, has a meagre feel, soils the fingers when handled, and so light as nearly to float in water. It effervesces, and is dissolved in acids, and appears to be a carbonate of lime. It is found in fissures of secondary limestone rocks in Switzerland, and at Sunderland in Durham.

BERNACLE. See Anas.

BERNARD (Dr. Edward), a learned astronomer, critic, and linguist, was born at Perry St. Paul, near Towcester, the 2d of May 1638, and educated at Merchant-Taylor's school, and at St. John's college, Oxford. Having laid in a good fund of classical learning at school, in the Greek and Latin languages, he applied himself very diligently at the university to the study of history, the eastern languages, and mathematics under the celebrated Dr. Wallis. In 1668 he went to Leyden to consult some

Oriental manuscripts left to that university by Joseph Scaliger and Levin Warner, and especially the 5th, 6th, and 7th books of Apollonius's Conics, the Greek text of which is lost, and this Arabic version having been brought from the east by the celebrated Golius, a transcript of which was thence taken by Bernard, and brought with him to Oxford, with intent to publish it there with a Latin translation; but he was obliged to drop that design for want of encouragement. This however was afterwards carried into effect by Dr. Halley in 1710, with the addition of the 8th book, which he supplied by his own ingenuity and industry.

At his return to Oxford, Bernard examined and collated the most valuable manuscripts in the Bodleian library. In 1669, the celebrated Christopher Wren, Savilian professor of astronomy at Oxford, having been appointed Surveyor-General of his Majesty's works, and being much detained at London by this employment, obtained leave to name a deputy at Oxford, and pitched upon Mr. Bernard, which engaged the latter in a more particular application to the study of astronomy. But in 1673 he was appointed to the professorship himself, which Wren was obliged to resign, as, by the statutes of the founder, Sir Henry Saville, the professors are not allowed to hold any other office either ecclesiastical or civil.

About this time a scheme was set on foot at Oxford, of collecting and publishing the ancient mathematicians. Mr. Bernard, who had first formed the project, collected all the old books published on that subject since the invention of printing, and all the manuscripts he could discover in the Bodleian and Savilian libraries, which he arranged in order of time, and according to the matter they contained; of this he drew up a synopsis or view; and as a specimen he published a few sheets of Euclid, containing the Greek text, and a Latin version, with Proclus's commentary in Greek and Latin, and learned scholia and corollaries. The synopsis itself was published by Dr. Smith, at the end of his life of our author, under the title of "Veterum Mathematicorum Græcorum, Latinorum, et Arabum, Synopsis." And at the end of it there is a catalogue of some Greek writers, whose works are supposed to be lost in their own language, but are preserved in the Syriac or Arabic translations of them.

Toward the latter end of his life he was much afflicted with the stone; yet notwithstanding this, and other infirmities, he undertook a voyage to Holland, to attend the sale of Golius's manuscripts, as he had once before done at the sale of Heinsius's library. On his return to England, he fell into a languishing consumption, which put an end to his life the 12th of January 1696, in the 58th year of his age. He was the author of many valuable works.

BERNOULLI (James), a celebrated mathematician, born at Basil the 27th of December, 1654. Having taken his degrees in that university, he applied himself to divinity at the entreaties of his father, but against his own inclination, which led him to astronomy and mathematics. He gave very early proofs of his genius for these sciences, and soon became a geometrician, without a preceptor, and almost without books; for if one by chance fell into his hands, he was obliged to conceal it, to avoid the displeasure of his father, who designed him for other studies. This situation induced him to choose for his device, Phaeton driving the chariot of the sun, with these words, *Invito patre sidera verso*, "I traverse the stars against my father's will:" alluding particularly to astronomy, to which he then chiefly applied himself.

In 1676 he began his travels. When he was at Geneva, he fell upon a method to teach a young girl to write who had been blind from two months old. At Bourdeaux he composed universal gnomonic tables; but they were never published. He returned from France to his own country in 1680. About this time there appeared a comet, the return of which he foretold; and wrote a small treatise upon it. Soon after this he went into Holland, where he applied himself to the study of the new philosophy. Having visited Flanders and Brabant, he passed over to England; where he formed an acquaintance with the most eminent men in the sciences, and was frequent at their philosophical meetings. He returned to his native country in 1682; and exhibited at Basil a course of experiments in natural philosophy and mechanics, which consisted of a variety of new discoveries. The same year he published his "Essay on a new System of Comets;" and the year following, his "Dissertation on the Weight of the Air." About this time Leibnitz having published, in the Acta Eruditorum at Leipsic, some essays on his new "Calculus Differentialis," but concealing the art and method of it, Mr. Bernoulli and his brother John discovered, by the little which they saw, the beauty and ex-

tent of it: this induced them to endeavour to unravel the secret; which they did with such success, that Leibnitz declared that the invention belonged to them as much as to himself.

In 1687, James Bernoulli succeeded to the professorship of mathematics at Basil; a trust which he discharged with great applause; and his reputation drew a great number of foreigners from all parts to attend his lectures. In 1699, he was admitted a foreign member of the Academy of Sciences of Paris; and in 1701, the same honour was conferred upon him by the Academy of Berlin: in both of which he published several ingenious compositions, about the years 1702, 3, and 4. He wrote also several pieces in the "Acta Eruditorum" of Leipsic, and in the "Journal des Sçavans." His intense application to study brought upon him the gout, and by degrees a slow fever, which put a period to his life the 16th of August 1705, in the 51st year of his age. Archimedes having found out the proportion of a sphere and its circumscribing cylinder, ordered them to be engraven on his monument. In imitation of him, Bernoulli appointed that a logarithmic spiral curve should be inscribed on his tomb, with these words, "Eadem mutata resurgo;" in allusion to the hopes of the resurrection, which are in some measure represented by the properties of that curve, which he had the honour of discovering.

James Bernoulli had an excellent genius for invention, and elegant simplicity, as well as a close application. He was eminently skilled in all the branches of the mathematics, and contributed much to the promoting the new analysis, infinite series, &c. He carried to a great height the theory of the quadrature of the parabola; the geometry of curve lines, of spirals, of cycloids, and epicycloids. His works, that had been published, were collected, and printed in 2 volumes 4to. at Geneva in 1744.

Bernoulli (John), the brother of James, last mentioned, and a celebrated mathematician, was born at Basil the 7th of August, 1667. His father intended him for trade; but his own inclination was at first for the Belles-Lettres, which however, like his brother, he left for mathematics. He laboured with his brother to discover the method used by Leibnitz, in his essays on the differential calculus, and gave the first principles of the integral calculus. Our author, with Messieurs Huygens and Leibnitz, was the first who gave the solution of the problem proposed by James Bernoulli, concerning the catenary, or curve formed by a chain suspended by its two extremities.

John Bernoulli was a member of most of the academies of Europe, and received as a foreign associate of that of Paris in 1699. After a long life spent in constant study and improvement of all the branches of the mathematics, he died full of honours the 1st of January, 1748, in the 81st year of his age. Of five sons which he had, three pursued the same sciences with himself. One of these died before him; the two others, Nicolas and Daniel, he lived to see become eminent and much respected in the same sciences.

The writings of this great man were dispersed through the periodical memoirs of several academies, as well as in many separate treatises. And the whole of them were carefully collected and published at Lausanne and Geneva, 1742, in 4 volumes, 4to.

Bernoulli (Daniel), a celebrated physician and philosopher, and son of John Bernoulli last mentioned, was born at Groningen, February the 9th, 1700, where his father was then professor of mathematics. He was intended by his father for trade, but his genius led him to other pursuits. He passed some time in Italy; and at 24 years of age he declined the honour offered him of becoming president of an academy intended to have been established at Genoa. He spent several years with great credit at Petersburgh; and in 1733 returned to Basil, where his father was then professor of mathematics; and here our author successively filled the chair of physic, of natural and of speculative philosophy.

Daniel Bernoulli wrote a multitude of pieces, which have been published in the Memoirs of the Academy of Sciences at Paris, and in those of other academies. He gained and divided ten prizes from the Academy of Sciences, which were contended for by the most illustrious mathematicians in Europe. The only person who has had similar success in the same line, is Euler, his countryman, disciple, rival, and friend. His first prize he gained at 24 years of age. In 1734 he divided one with his father; which hurt the family union; for the father considered the contest itself as a want of respect; and the son did not sufficiently conceal that he thought (what was really

the case) his own piece better than his father's. And besides, he declared for Newton, against whom his father had contended all his life. In 1740 our author divided the prize, "On the Tides of the Sea," with Euler and Maclaurin. The Academy at the same time crowned a fourth piece, the chief merit of which was that of being a Cartesian; but this was the last public act of adoration paid by the Academy to the authority of the author of the Vortices, which it had obeyed but too long. In 1748, Daniel Bernoulli succeeded his father John in the Academy of Sciences, who had succeeded his brother James; this place, since its first erection in 1699, having never been without a Bernoulli to fill it.

Our author was extremely respected at Basil; and to bow to Daniel Bernoulli, when they met him in the streets, was one of the first lessons which every father gave every child. He was a man of great simplicity and modesty of manners. He used to tell an anecdote which he said had given him more pleasure than all the other honours he had received. Travelling with a learned stranger, who, being pleased with his conversation, asked his name; "I am Daniel Bernoulli;" answered he with great modesty; "And I," said the stranger (who thought he meant to laugh at him), "am Isaac Newton."

After a long, useful, and honourable life, Daniel Bernoulli died the 17th of March, 1782, in the 83d year of his age.

BERRY, a round fruit, for the most part soft, and covered with a thin skin, containing seeds in a pulpy substance; but if it be harder, or covered with a thicker skin, it is called pomum, apple.

BERTIERA, in botany, so named from M. Bertier, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ, Linn. Bubiaceæ, Jussieu. Essential character: calyx turbinate, five-toothed; corol tube short with a villose mouth; berry globose, inferior, two-celled, many-seeded. There is but one species, *viz.* B. guianensis. This is a shrub six or seven feet in height, the thickness of the human arm; branches opposite, knotty, tomentose. Corolla white, found in the wood of Anonna in Guiana, flowering and fruiting in the month of June.

BERYLL, in mineralogy, a species of the flint genus, divided by Werner into two sub-species. 1st, Precious beryll, which is green passing on the one side into blue, and on the other into yellow; it is commonly mountain green and seladon; from the former it passes through various shades to the wine yellow; from the latter it passes into smalt, sky, and, in rare instances, into azure blue. Its colours are generally pale, sometimes two at once. It is crystallized in long equiangular six-sided prisms, which are perfect or truncated on the edges and angles. The crystals approach to trihedral, and sometimes to the oblique tetrahedral prisms: they are sometimes heaped on each other, the smaller ones being almost uppermost, thus forming a shape like a tower: and in other cases they are perforated in the direction of their axes. It is commonly transparent, but passing to the translucent, and is slightly duplicating. It is hard; scratches quartz; nearly equal in hardness to topaz, with which the mountain green variety has often been confounded. Easily frangible: and the specific gravity is 2.6 or 2.7. Before the blow-pipe it is difficultly fusible without addition, but with borax it melts easily: it is composed of

Silica	68.0
Alumina	15.0
Glucine	14.0
Lime	2.0
Oxide of iron	1.0
	100.0

It becomes very electrical by rubbing: is found in primitive rocks, accompanied with quartz, felspar, garnet, mica, fluor spar, and topaz. The most beautiful specimens are brought from China and the Brazils. They are found also in the Uralian mountains, in France, and in Saxony. When pure it is cut into stones for rings and necklaces. Its plenty renders it of no great value. It was well known to the ancients, who procured it from several places where it is now found. It is mentioned by Pliny and others: the blue varieties were denominated saphire; the green, aqua marine, and the yellow, topaz.

The 2d variety is denominated schorlous beryll, which is of a straw colour, passing to white, green and yellow. The crystals are large, middle sized, and hard, but yielding to the file; it is brittle, and very easily frangible; specific gravity about 3.5. It melts with borax into a pure transparent glass, and consists of

Silica	50
Alumina	50
	100

It is found embedded in quartz and mica,

in many parts of Germany: it is the link that unites the precious beryll with schorl.

BESANT, or BEZANT, a coin of pure gold, of an uncertain value, struck at Byzantium, in the time of the Christian Emperors; from hence the gold offered by the King at the altar, is called besant, or bisant.

BESANTS, in heraldry, round pieces of gold, without any stamp, frequently borne in coats of arms.

BESLERIA, in botany, a genus of the Didynamia Angiospermia class of plants. Its flower consists of a single ringent petal. Its fruit is a berry of a globose form, containing only one cell, in which are several seeds, very small, and of a roundish figure. There are six species.

BESORCH, a coin of tin, or some alloyed metal, current at Ormus, at the rate of $7\frac{7}{49}$ parts of a farthing sterling.

BETA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Holoraceæ; Atriplices, Jussieu. Essential character; calyx five-leaved; corolla none; seed kidney-form, within the substance of the base of the calyx. There are four species, of which B. vulgaris, red garden beet, has large thick succulent leaves, which are for the most part of a dark red, or purple colour. The roots are large and deep red, and on these circumstances their goodness depends; for the longer they grow the more tender they will be; and the deeper their colour, the more they are esteemed. Native of the sea coast of the Southern parts of Europe. B. cicla, white garden beet, seldom grows larger than a man's thumb; the stalks grow erect, and have oblong, spear-shaped leaves growing close to the stalk; the spikes of the flowers are axillary, long, and have narrow leaves placed between the flowers. The lower leaves are thick and succulent, and their foot-stalks are broad. For these it is cultivated; the leaves being boiled as spinach, or put into soups, and the stalks and midrib of the leaf being stewed and eaten as asparagus.

A large variety of this has lately been introduced from abroad, under the title of root of scarcity. It is much cultivated in many parts of the continent, not only in gardens, but in the fields; being much more in esteem, and perhaps really better than with us, where it seems to degenerate. The leaf and root are said to be excellent food for man and beast; it is affirmed not to be liable to destruction by insects; nor to be affected by drought. The leaves are recommended as equal in quality to spinach, and, being from thirty to forty inches long, and from twenty-two to twenty-five broad, exceed it greatly in quantity. They may also be gathered every twelve or fifteen days during the season. We are told in the Gentleman's Magazine, that three varieties appeared from seeds procured from Dr. Lettsom. 1. With leaves and stem dark green, which was the most common. 2. With stem and leaves of a lighter colour, which he takes to be the white beet. 3. With stem and veins of the leaves red, which he says is the red beet. All of them have flowers in clusters, from two to three; pistils from two to five; a leaf growing from the base of the flowers; the segments of the calyx equal, hunched, and membranaceous at the edge; few plants flowering the first year, he concludes it to be biennial; as indeed all the garden sorts are, if not the wild sea beet also, although Linnæus sets it down as annual, and Ray as perennial. Dr. Lettsom, who took much pains to introduce the mangel wurzel, informs us, that on his own land, which was not favourable to its growth, the roots, upon an average, weighed full ten pounds, and if the leaves were calculated at half that weight, the whole product would be fifteen pounds of nutritious aliment upon every square of eighteen inches.

BETONY, *betonica*, in botany, a genus of the Didynamia Gymnospermia class of plants, whose flower, consisting of a single labiated petal, is of a bright red colour, and disposed in short spikes; the cup contains four ovated seeds. The species of this genus, of which there are seven, besides varieties, are herbaceous, fibrous-rooted, hardy, perennial plants, and the stems are simple, or but little branched. The flowers are in whorls, forming a terminating spike. B. officinalis, wood betony, is a native of woods, heaths, and pastures among bushes, flowering from the beginning of July to September. Betony, says Linnæus, was formerly much used in medicine, but it is discarded from modern practice. When fresh, it intoxicates. The leaves, when dry, excite sneezing.

Sheep eat it, but goats refuse it. The leaves and flowers have an herbaceous, roughish, and somewhat bitterish taste, with a weak aromatic flavour. An infusion or light decoction of them may be drank as tea, or a saturated tincture in rectified spirit may be given in laxity and debility of viscera. The roots are bitter and very nauseous; in a small dose they vomit and

purge violently. This plant dies wool of a very fine dark yellow colour.

BETULA, the *birch-tree*, in botany, a genus of plants of the Monoecia Tetrandria class. The male flower is amentaceous, formed of a number of monopetalous floscules, each of which is divided into four parts. In the female flower the calyx is lightly divided into three segments: the fruit is a cylindric cone, and the seeds are on each side edged with a membrane. The alder, B. alnus, as well as the B. alba, belongs to this genus; but of all the species we shall notice only the latter or common birch-tree, which is known at first sight by the silvery colour of its bark, the smallness of the leaves, and the lightness and airiness of the whole appearance. It is of rather an inferior size among the forest trees. The branches are alternate, subdivided, very pliant, and flexible, covered with a reddish brown or russet, smooth back, generally dotted with white. Leaves are alternate, bright green, smooth, shining beneath, with veins crossing like the meshes of a net; the petioles are half an inch or more in length, smooth, grooved above, and at the base are ovate green glands. The birch is a native of Europe, from Lapland to Italy, and of Asia, chiefly in mountainous situations, flowering with us in April and May. The twigs are erect in young trees, but being slender and pliant, they are apt to become pendent in old ones: hence there is a variety B. pendula, as beautiful as the weeping willow. Another variety, named from Dalecarlia, where it is found, has leaves almost palmate, with segments toothed.

The B. alba, though the worst of timber, is highly useful for articles of small manufactures, as ox-yokes, bowls, dishes, ladles, and divers other domestic utensils. In America they make their canoes, boxes, buckets, dishes, &c. from the birch: from an excrescence or fungus they form excellent touch-wood, and being reduced to powder, it is reckoned a specific for the piles. It is used as fuel, and will bear being burnt into excellent charcoal. The inner silken bark, which strips off of itself almost annually, was formerly used for writing before the invention of paper. In Russia and Poland the coarser bark is used instead of tiles or slates for the covering of houses; and in almost all countries the twigs have been used by pedagogues to keep their pupils in order, and to maintain diligence and discipline in the schools: and also for brooms used in domestic economy. The bark is used in processes of dying: and in Scotland for tanning leather and making ropes. In Kamtschatka they form the bark into hats and drinking-cups.

The vernal sap of the birch-tree is made into wine. In the beginning of March, while the sap is rising, holes must be bored in the body of the tree, and fossets made of elder placed in them to convey away the liquid. If the tree be large, it may be tapped in several places at a time, and thus according to the number of trees, the quantity of liquid is obtained. The sap is to be boiled with sugar in the proportion of four pounds to a gallon, and treated in the same way as other made wines. One great advantage attaching to the birch is, that it will grow on almost any barren ground: upon ground, says Martyn, that produced nothing but moss, birch-trees have succeeded, so as to produce at least 20*s*. per acre per ann. The broom-makers are constant customers for birch, in all places within 20 miles of the metropolis, or where water carriage is convenient; in other parts the hoop-benders are the purchasers; but the larger trees are consumed by turners, and the manufacturers of instruments of husbandry.

BEVEL, among masons, carpenters, joiners, and bricklayers, a kind of square, one leg whereof is frequently crooked, according to the sweep of an arch or vault. It is moveable on a centre, and may be set to any angle.

The make and use of this instrument is pretty much the same as those of the common square and mitre, except that those are fixed, the first at an angle of ninety degrees, and the second at forty-five; whereas the bevel being moveable, it may in some measure supply the place of both, which it is chiefly intended for, serving to set off or transfer angles, either greater or less than ninety or forty-five degrees.

BEVILE, in heraldry, a thing broken or opening like a carpenter's rule: thus we say, he beareth argent, a chief bevile, vert, by the name of beverlis.

BIBLE, *the book*, a name given by Christians, by way of eminence, to a collection of the sacred writings.

This collection of the sacred writings, containing those of the Old and New Testament, is justly looked upon as the foundation of the Jewish as well as the Christian religion. The Jews, it is true, acknowledge only the scriptures of the Old Testament, the correcting and publishing of which are unanimously ascribed, both by the Jews and

the Christians, to Ezra. Some of the ancient fathers, on no other foundation than that fabulous and apocryphal book, the second book of Esdras, pretend that the scriptures were entirely lost in the Babylonish captivity, and that Ezra had restored them again by divine revelation. What is certain is, that in the reign of Josiah, there were no other books of the law extant, besides that found in the temple by Hilkiah; from which original, that pious king ordered copies to be immediately written out, and search made for all the parts of the scriptures; by which means copies of the whole became pretty numerous among the people, who carried them with them into captivity. After the return of the Jews from the Babylonish captivity, Ezra got together as many copies as he could of the sacred writings, and out of them all prepared a correct edition, disposing the several books in their natural order, and settling the canon of the scripture for his time; having published them, according to the opinion of most learned men, in the Chaldee character, as the Jews, upon their return from the captivity, brought with them the Chaldaic language, which from that time became their mother tongue, and probably gave birth to the Chaldee translation of their scriptures.

Bible, *Chaldee*, is only the glosses, or expositions made by the Jews, when they spoke the Chaldee tongue; whence it is called *targumim*, or paraphrases, as not being a strict version of the scriptures.

Bible, *Hebrew*. There is, in the church of St. Dominic, in Bononia, a copy of the Hebrew scriptures, which they pretend to be the original copy, written by Ezra himself. It is written in a fair character, upon a sort of leather, and made up into a roll, after the ancient manner; but its having the vowel points annexed, and the writing being fresh and fair, without any decay, are circumstances which prove the novelty of the copy.

Bible, *Greek*. It is a dispute among authors, whether there was a Greek version of the Old Testament, more ancient than that of the 72 Jews employed by Ptolemy Philadelphus to translate that book: before our Saviour's time, there was no other version of the Old Testament besides that which went under the name of the LXX.

But, after the establishment of Christianity, some authors undertook new translations of the Bible, under pretence of making them more conformable to the Hebrew text. There have been about six of these versions, some of which are charged with having corrupted several passages of the prophets relating to Jesus Christ; others have been thought too free in their versions, and others have been found fault with, for having confined themselves too servilely to the letter.

Bible, *Latin*. It is beyond dispute, that the Latin churches had, even in the first ages, a translation of the Bible in their language; which being the vulgar language, and consequently understood by every body, occasioned a vast number of Latin versions. Among these there was one which was generally received, and called by St. Jerom, the vulgar or common translation. St. Austin gives this version the name of the Italic, and prefers it to all the rest. See Vulgate.

There were several other translations of the Bible into Latin, the most remarkable of which are the versions of St. Jerom, Santes Pagninus, Cardinal Cajetan, and Isiodore Clarius, all from the Hebrew text. Besides these translations by Catholic authors, there are some made by Protestant translators of the Hebrew; the most eminent of their versions are those of Sebastian Munster, Leo Juda, Sebastian Castalio, Theodore Beza, Le Clerc, &c.

Bible, *Syriac*. The Syrians have in their language a version of the Old Testament, which they pretend to be of great antiquity, most part of which they say was made in Solomon's time, and the rest in the time of Abgarus king of Edessa.

Bible, *Arabic*. The Arabic versions of the Bible are of two sorts, the one done by Christians, the other by Jews. There are also several Arabic versions of particular books of scripture, as a translation of the Pentateuch from the Syriac, and another of the same from the Septuagint, and two other versions of the Pentateuch, the manuscripts of which are in the Bodleian library.

The Gospel being preached in all nations, the Bible, which is the foundation of the Christian religion, was translated into the respective languages of each nation; as the Egyptian or Coptic, the Indian, Persian, Armenian, Ethiopic, Scythian, Sarmatian, Sclavonian, Polish, Bohemian, German, English, &c.

The books of the Bible are divided by the Jews into three classes, *viz.* the law, the prophets, and the hagiographers; a division which they are supposed to borrow from Ezra himself.

Each book is subdivided into sections, or *parasches;* which some maintain to have been as old as Moses, though others, with more probability, ascribe it to the same Ezra. These were subdivided into verses, *pesuchim,* marked in the Hebrew Bible by two great points, called *soph pasuch,* at the end of each. For the division of the Bible into chapters, as we now have it, is of much later date.

Divers of the ancient Bible-books appear to be irrecoverably lost, whether it be that the copies of them perished, or that Ezdras threw them out of his canon. Hence it is, that in the books still extant, we find divers citations of, and references to, others, which are now no more; as the book of Jasher, the book of the wars of the Lord, annals of the kings of Judah and Israel, part of Solomon's three thousand proverbs, and his thousand and five songs, besides his books on plants, animals, fishes, insects, &c. To which may be added, a book of Jeremiah, wherein he enjoined the captives who went to Babylon, to take the sacred fire and conceal it; also the precepts which that prophet gave the Jews to preserve themselves from idolatry, and his lamentations on the death of king Josiah.

The Jewish canon of scripture then was settled by Ezra; yet not so but that several variations have been since made in it: Malachi, for instance, could not be put in the Bible by him, since that prophet is allowed to have lived after Ezra; nor could Nehemiah be there, since mention is made in that book of Jaddua, as high priest, and of Darius Codomannus as king of Persia, who were at least an hundred years later than Ezra. It may be added, that, in the first book of Chronicles, the genealogy of the sons of Zerubbabel is carried down for so many generations, as must necessarily bring it to the time of Alexander; and consequently this book could not be in the canon in Ezra's days. It is probable the two books of Chronicles, Ezra, Nehemiah, Esther, and Malachi, were adopted into the Bible in the time of Simon the Just, the last of the men of the great synagogue.

Bibles, *English-Saxon.* If we inquire into the versions of the Bible of our own country, we shall find that Adelm, bishop of Shireborn, who lived in 709, made an English-Saxon version of the Psalms; and that Eadfrid, or Ecbert, bishop of Lindisferne, who lived about the year 730, translated several of the books of scripture into the same language. It is said likewise, that venerable Bede, who died in 785, translated the whole Bible into Saxon. But Cuthbert, Bede's disciple, in the enumeration of his master's works, speaks only of his translation of the Gospels; and says nothing of the rest of the Bible. Some pretend, that King Alfred, who lived in 890, translated a great part of the Scriptures. We find an old version in the Anglo-Saxon of several books of the Bible, made by Elfric, abbot of Malmesbury: it was published at Oxford in 1699. There is an old Anglo-Saxon version of the four Gospels, published by Matthew Parker, Archbishop of Canterbury, in 1571, the author whereof is unknown. Dr. Mill observes, that this version was made from a Latin copy of the old Vulgate.

Bibles, *Saxon.* The whole scripture is said by some to have been translated into the Anglo-Saxon by Bede, about the year 701, though others contend he only translated the Gospels. We have certain books or parts of the Bible, by several other translators; as, 1. The Psalms, by Adelm, bishop of Shireborn, contemporary with Bede; though by others this version is attributed to King Alfred, who lived 200 years after. Another version of the Psalms in Anglo-Saxon was published by Spelman, in 1640. 2. The Evangelists, still extant, done from the ancient Vulgate, before it was revised by St. Jerome, by an author unknown, and published by Matth. Parker, in 1571. An old Saxon version of several books of the Bible, made by Elfric, abbot of Malmesbury, several fragments of which were published by William Lilly, in 1638, the genuine copy by Edm. Thwaites, in 1639, at Oxford.

Bibles, *Indian.* A translation of the Bible into the North American Indian language, by Elliot, was published in 4to. at Cambridge, in 1685.

Bibles, *English.* The first English Bible we read of, was that translated by J. Wickliffe, about the year 1360; but never printed, though there are MS. copies of it in several of the public libraries. J. de Trevisa, who died about the year 1398, is also said to have translated the whole Bible; but whether any copies of it are remaining, does not appear.

Tindal's. The first printed Bible in our language, was that translated by Will. Tindal, assisted by Miles Coverdale, printed abroad in 1526; but most of the copies were bought up and burnt by Bishop Tunstal and Sir Thomas More. It only contained the New Testament, and was re-

vised and republished by the same person in 1530. The prologues and prefaces added to it reflect on the bishops and clergy; but this edition was also suppressed, and the copies burnt. In 1532, Tindal and his associates finished the whole Bible, except the Apocrypha, and printed it abroad; but while he was afterwards preparing for a second edition, he was taken up and burnt for heresy in Flanders.

Matthews's. On Tindal's death, his work was carried on by Coverdale, and John Rogers, superintendent of an English church in Germany, and the first martyr in the reign of Queen Mary, who translated the Apocrypha, and revised Tindal's translation, comparing it with the Hebrew, Greek, Latin, and German, and adding prefaces and notes from Luther's Bible. He dedicated the whole to Henry VIII. in 1537, under the borrowed name of Thomas Matthews; whence this has been usually called Matthews's Bible. It was printed at Hamburgh, and licence obtained for publishing it in England, bv the favour of Archbishop Cranmer, and the Bishops Latimer and Shaxton.

Cranmer's. The first Bible printed by authority in England, and publicly set up in churches, was the same Tindal's version revised, compared with the Hebrew, and in many places amended, by Miles Coverdale, afterwards bishop of Exeter; and examined after him by Archbishop Cranmer, who added a preface to it: whence this was called Cranmer's Bible. It was printed by Grafton, of the largest volume, and published in 1540; and, by a royal proclamation, every parish was obliged to set one of the copies in their church, under the penalty of forty shillings a month; yet, two years after, the Popish bishops obtained its suppression of the king. It was restored under Edward VI. suppressed again under Queen Mary, and restored again in the first year of Queen Elizabeth, and a new edition of it given in 1562.

Geneva. Some English exiles at Geneva in Queen Mary's reign, Coverdale, Goodman, Gilbie, Sampson, Cole, Whittingham, and Knox, made a new translation, printed there in 1560, the New Testament having been printed in 1557, hence called the Geneva Bible, containing the variations of readings, marginal annotations, &c. on account of which it was much valued by the Puritan party in that and the following reigns.

Bishops. Archbishop Parker resolved on a new translation for the public use of the church, and engaged the bishops and other learned men to take each a share or portion. These being afterwards joined together, and printed with short annotations in 1568, in a large folio, made what was afterwards called the great English Bible, and commonly the Bishop's Bible. The following year it was also published in 8vo. in a small, but fine black letter, and here the chapters were divided into verses; but without any breaks for them, in which the method of the Geneva Bible was followed, which was the first English Bible where any distinction of verses was made. It was afterwards printed in large folio, with corrections, and several prolegomena, in 1572: this is called Matthew Parker's Bible. The initial letters of each translator's name were put at the end of his part: *e. gr.* at the end of the Pentateuch, W. E. for William Exon; that is, William Bishop of Exeter, whose allotment ended there: at the end of Samuel, R. M. for Richard Menevensis, or Bishop of St. David's, to whom the second allotment fell: and the like of the rest. The archbishop foresaw, directed, examined, and finished the whole. This translation was used in the churches for 40 years, though the Geneva Bible was more read in private houses, being printed above 30 times in as many years. King James bore it an inveterate hatred on account of the notes, which at the Hampton-court conference he charged as partial, untrue, seditious, &c. The Bishop's Bible too had its faults. The king frankly owned he had yet seen no good translation of the Bible in English; but he thought that of Geneva the worst of all.

Rhemish. After the translation of the Bible by the bishops, two other private versions had been made of the New Testament: the first by Laurence Thomson, made from Beza's Latin edition, together with the notes of Beza, published in 1582 in 4to., and afterwards in 1589, varying very little from the Geneva Bible; the second by the Papists at Rheims, in 1584, called the Rhemish Bible, or Rhemish translation. These finding it impossible to keep the people from having the Scriptures in the vulgar tongue, resolved to give a version of their own, as favourable to their cause as might be. It was printed in a large paper, with a fair letter and margin. One complaint against it was its retaining a multitude of Hebrew and Greek words untranslated, for want, as the editors express it, of proper and adequate terms in the English to render them by, as

the words *azymes, tunike, rational, holocaust, prepuce, pasche*, &c. However, many of the copies were seized by the queen's searchers, and confiscated; and Thomas Cartwright was solicited by Secretary Walsingham to refute it: but, after a good progress made therein, Archbishop Whitgift prohibited his further proceeding therein, as judging it improper that the doctrine of the Church of England should be committed to the defence of a Puritan, and appointed Dr. Fulke in his place, who refuted the Rhemists with great spirit and learning. Cartwright's refutation was also afterwards published in 1618, under Archbishop Abbot. About 30 years after their New Testament, the Roman Catholics published a translation of the Old at Doway, in 1609 and 1610, from the Vulgate, with annotations; so that the English Roman Catholics have now the whole Bible in their mother tongue; though it is to be observed, they are forbidden to read it without a license from their superiors.

King James's. The last English Bible was that which proceeded from the Hampton-court conference, in 1603, where many exceptions being made to the Bishop's Bible, King James gave orders for a new one; not, as the preface expresses it, for a translation altogether new, nor yet to make of a bad one a good one; but to make a good one better, or of many good ones one best. Fifty-four learned persons were appointed for this office by the king, as appears by his letter to the archbishop, dated in 1604; which being three years before the translation was entered upon, it is probable seven of them were either dead or had declined the task, since Fuller's list of the translators makes but 47; who being ranged under six divisions, entered on their province in 1607. It was published in 1613, with a dedication to James, and a learned preface, and is commonly called King James's Bible. After this, all the other versions dropped and fell into disuse, except the Epistles and Gospels in the Common Prayer Book, which were still continued according to the Bishops translation till the alteration of the liturgy in 1661, and the Psalms and Hymns, which are to this day continued as in the old version. The judicious Selden, in his Table Talk, speaking of the Bible, says, "The English translation of the Bible is the best translation in the world, and renders the sense of the original best, taking in for the English translation the Bishops Bible as well as King James's. The translators in King James's time took an excellent way. That part of the Bible was given to him who was most excellent in such a tongue (as the Apocrypha to Andrew Downs), and then they meet together, and one read the translation, the rest holding in their hands some Bible, either of the learned tongues, or French, Spanish, Italian, &c. If they found any fault, they spoke; if not, he read on." King James's Bible is that now read by authority in all the churches in Britain.

Bibles, *Welsh.* There was a Welsh translation of the Bible made from the original in the time of Queen Elizabeth, in consequence of a bill brought into the House of Commons for this purpose in 1563. It was printed in folio in 1588. Another version, which is the standard translation for that language, was printed in 1620. It is called Parry's Bible. An impression of this was printed in 1690, called Bishop Lloyd's Bible. These were in folio. The first 8vo. impresson of the Welsh Bible was made in 1630.

Bibles, *Irish.* Towards the middle of the sixteenth century, Bedell, Bishop of Kilmore, set on foot a translation of the Old Testament into the Irish language; the New Testament and the Liturgy having been before translated into that language. The bishop appointed one King to execute this work, who not understanding the Oriental languages, was obliged to translate it from the English. This work was received by Bedell, who, after having compared the Irish translation with the English, compared the latter with the Hebrew, the LXX. and the Italian version of Diodati. When this work was finished, the bishop would have been himself at the charge of the impression, but his design was stopped upon advice given to the Lord Lieutenant and the Archbishop of Canterbury, that it would prove a shameful thing for a nation to publish a Bible translated by such a despicable hand as King. However the manuscript was not lost, for it went to press in the year 1685.

Bibles, *Erse.* There is also a version of the Bible in the Gaelic, or Erse language, published at Edinburgh.

BIDENS, in botany, a genus of the Syngenesia Polygamia Æqualis class of plants. The compound flower is uniform and tubulose, and the proper one infundibuliform. The seed is single, obtuse, and crowned with two or more erect and sharp awns. There are 14 species, most of which are herbaceous annuals. Some however are shrubs. Leaves generally opposite, some

pinnate. Flowers axillary or terminating. B. tripartita is obviously distinguished from B. cernua, drooping water hemp agrimony, by its trifid leaves, a character more to be depended on than the uprightness of its flowers. It is also much more common with us at least. That is generally found in water; this more frequently occurs on the borders of ponds, rivulets, &c. where it flowers in August and September. This plant dyes a deep yellow. The yarn or thread must be first steeped in alum water, then dried and steeped in a decoction of the plant, and afterwards boiled in the decoction. The seeds have been sometimes known to destroy gold-fish, by adherring to their gills and jaws.

BIENNIAL *plants*, in botany, such as are of two years duration. Of this kind there are numerous plants, which being raised one year from seed, generally attain perfection in the same year, shooting up stalks, producing flowers, and perfecting seeds in the following spring or summer, and soon after perish.

BIGAMY, in law, is where a person marries a second wife, or husband, the first being alive, for which the punishment was formerly death, as in cases of felony; but it is now usually punished with a long imprisonment or even transportation; and in the case of a spy, employed by government in the year 1794, who was convicted of bigamy, the punishment was the mere residence in the house of the jailor for a very few days.

BIGNONIA, the *trumpet-flower*, in botany, a genus of the Didynamia Angiospermia class. The flower is monopetalous, with a mouth campanulated, and divided into five segments: the fruit is a pod with two cells and two valves, containing several imbricated, compressed, and winged seeds. There are 27 species, mostly trees and shrubs, inhabitants of the hot climates of the East and West Indies, and eminently beautiful. Flowers in panicles, large and handsome, of various colours, red, blue, yellow, or white. The calyx should be observed, whether it be simple or double; the corolla, whether it be regular or irregular; the stamens, whether they be fertile or barren; the fruit, whether it be bony or capsular, in form of a silique or ovate. B. catalpa is a deciduous tree, rising with an upright stem, covered with a smooth brown bark, to the height of thirty or forty feet: it sends out many strong lateral branches, having very arge heart-shaped leaves on them, placed opposite at every point. The flowers are succeeded by long taper pods; but these have not yet been produced in England; it is found growing naturally on the back of South Carolina, at a great distance from the English settlements. It is now not uncommon in our nurseries and plantations. This tree has a good effect when it stands in the middle of large openings, where it can freely send forth its side branches and shew itself to advantage. It flowers in August, and is known in the nurseries by its Indian name Catalpa.

BILBOES, a punishment at sea, answering to the stocks at land. The offender is laid in irons, or stocks, which are more or less ponderous, according to the quality of the offence of which he is guilty.

BILDGE of a ship, the bottom of her floor, or the breadth of the place the ship rests on when she is aground. Therefore, bildge-water is that which lies on her floor, and cannot go to the well of the pump: and bildge-pumps, or burr-pumps, are those that carry off the bildge-water. They likewise say the ship is bildged, when she has some of her timber struck off on a rock or anchor, and springs a leak.

BILDSTEIR, a mineral called by Klaproth Agalmatolite, of which there are two varieties. The first is semitransparent, its colour is olive and asparagus green, passing into greenish grey, internally it is shining, and has a greasy lustre: its parallel fracture is obscurely slaty, its cross fracture is small splintery passing to compact uneven: it is translucid, soft, and has a greasy feel. Specific gravity 2.81: according to Klaproth it contains,

Silex..........	54
Alumina	36
Oxide of iron....	0.75
Water..........	5.50
Loss............	3.75
	100.00

The second variety is opaque, and is of a reddish white passing into flesh-red, and variegated with different coloured veins: it possesses little or no lustre, and has a compact fracture; it consists of

Silex..........	62
Alumina	24
Lime	1
Oxide of iron....	0.5
Water............	10.0
Loss.............	2.5
	100.0

Bildsteir comes from China, and is the substance of which the little Chinese ornaments and figures of chimney-pieces are made.

BILE is a liquid of a yellowish-green colour, an unctuous feel, bitter taste, and peculiar smell, which is secreted by the liver; and in most animals considerable quantities of it are usually found collected in the gall bladder. Great attention has been paid to this liquid by physicians; because the ancients were accustomed to ascribe a very great number of diseases, and even affections of the mind, to its agency. The specific gravity of bile seems to vary, like that of all other animal fluids. When strongly agitated, it lathers like soap; and for this reason, as well as from a medical theory concerning its use, it has been often called an animal soap. It mixes readily with water in any proportion, and assumes a yellow colour; but it refuses to unite with oil; when the two fluids are agitated together, the instant that they are left at rest the oil separates and swims on the surface. Bile, however, dissolves a portion of soap readily, and is often employed to free cloth from greasy spots. When muriatic acid is poured upon bile, let it be ever so fresh, an odour of sulphurated hydrogen gas is constantly exhaled. When on 100 parts of ox bile, 4 parts of strong muriatic acid are poured, the whole instantly coagulates; but in some hours the greater part becomes again fluid; and when passed through the filtre, it leaves 0.26 of a white matter, which has all the properties of albumen. Thenard, by a careful and repeated analysis of ox bile, found that 800 parts of it yielded the following ingredients:

Water	700
Resin	43
Saccharine matter	41
Albumen	4
Soda	4
Muriate of soda	3.2
Sulphate of soda	0.8
Phosphate of soda	2 0
Phosphate of lime	1.2
Oxide of iron	0.5
	799.7

When bile is distilled in a water-bath, it affords a transparent watery liquor, which contracts a pretty strong odour, not unlike that of musk or amber, especially if the bile has been kept for some days before it is submitted to distillation.

Bile, exposed to a temperature between 65° and 75°, soon loses its colour and viscidity, acquires a nauseous smell, and deposits whitish mucilaginous flakes. After the putrefaction has made considerable progress, its smell becomes sweet, and resembles amber. If bile he heated, and slightly concentrated by evaporation, it may be kept for many months without alteration.

The principal use of the bile seems to be to separate the excrement from the chyle, after both have been formed, and to produce the evacuation of the excrement out of the body. It is probable that these substances would remain mixed together, and that they would perhaps even be partly absorbed together, were it not for the bile, which seems to combine with the excrement, and by this combination to facilitate its separation from the chyle, and thus to prevent its absorption. Fourcroy supposes that the bile, as soon as it is mixed with the contents of the intestinal canal, suffers a decomposition; that its alkali and saline ingredients combine with the chyle, and render it more liquid, while its albumen and resin combine with the excrementitious matter, and gradually render them less fluid. From the late experiments of Berzelius on feces, it cannot be doubted that the constituents of the bile are to be found in the excrementitious matter: so that the ingenious theory of Fourcroy is so far probable. The bile also stimulates the intestinal canal, and causes it to evacuate its contents sooner than it otherwise would do; for when there is a deficiency of bile, the body is constantly costive.

BILINGUIS, in a general sense, signifies one that speaks two languages; but in law it is used for a jury that passes in any case between an Englishman and a foreigner, whereof part ought to be English and part strangers.

BILL, an instrument made of iron, edged in the form of a crescent, and adapted to a handle. It is used by plumbers, to perform several parts of their work; by basket-makers, to cut the largest pieces of chesnut trees and other wood; and by gardeners, to prune trees. When short, it is called a hand bill, and when long, a hedge-bill.

BILL *in trade*, both wholesale and retail, as also among workmen, signifies an account of merchandizes or goods delivered to a person, or of work done for one. In those bills must be set down the sums of money received on account, which ought to be deducted from the sum total.

BILL *of credit*, that which a merchant or

banker gives to a person whom he can trust, impowering him to receive money from his correspondents in foreign countries. Though bills of credit be different from bills of exchange, yet they enjoy the same privileges; for the money paid in consequence of them is recoverable by law.

Bill *of entry*, an account of the goods entered at the custom-house, both inwards and outwards. In this bill must be expressed, the merchant exporting or importing; the quantity of merchandise, and the divers species thereof; and whither transported, or from whence.

Bill *of exchange*, a piece of paper on which is written a short order, given by a merchant, &c. for paying to such a person, or his order, and in some countries to the bearer in a distant place, a sum of money equivalent to that which such a merchant, &c. has received in his dwelling-house.

There are three things necessary to constitute a bill of exchange. 1. That it be drawn in one city upon another. 2. That there be three persons concerned, the drawer, the presenter, or person for whom it is drawn, and the acceptor, or he on whom it is drawn. And, 3. That it make mention, that the value which the drawer has received is either in bills of exchange, in money, merchandise, or other effects, which are to be expressed.

These bills are made payable either at sight, or so many days, weeks, or months after date; the space of a month being called usance, and two or three months after date, double or treble usance. There is a difference between an inland bill and foreign bill; for an inland bill of exchange is said to be only in the nature of a letter; but a foreign or outland bill is more regarded in law; because it is for the advantage of commerce with other countries, which makes it of a public concern.

Not only the drawer, but every indorser of a bill is liable for the payment thereof; for an indorser charges himself in the same manner as if he had originally drawn the bill: and a plaintiff, in an action in such case, is not obliged to prove the drawer's hand, because the indorser is as a new drawer; but he must make proof that he demanded the money of the drawer, or drawers, or that he sought after, and could not find them in convenient time: for, by the custom among merchants, the indorsee is to receive the money of the first drawer, if he can, and if he cannot, then, and not before, the indorser must answer it.

The forging bills of exchange, or any acceptance, and stealing such bills for money is felony.

Bill *of lading*, an acknowledgment signed by the master of a ship, and given to a merchant, &c. containing an account of the goods which the master has received on board from that merchant, &c. with a promise to deliver them at an intended place for a certain salary. Each bill of lading must be treble, one for the merchant who loads the goods, another to be sent to the person to whom they are consigned, and the third to remain in the hands of the master of the ship. It must be observed, however, that a bill of lading is used only when the goods sent on board a ship are but part of the cargo: for when a merchant loads a whole vessel for his own personal account, the deed passed between him and the master of the ship is called charter party.

Bill *of parcels*, an account given by the seller to the buyer, containing the particulars of all the sorts and prices of the goods bought.

Bill *of sale*, is when a person wanting a sum of money, delivers goods as a security to the lender, to whom he gives this bill, impowering him to sell the goods, in case the sum borrowed is not repaid, with interest, at the appointed time.

Bill *of store*, a licence granted at the custom-house to merchants, by which they have liberty to carry, custom-free, all such stores and provisions as they may have occasion for during their voyage.

Bill *of sufferance*, a licence granted to a merchant at the custom-house, suffering him to trade from one English port to another, without paying custom.

Bill, *bank*, a private instrument, whereby private persons become entitled to a part in the bank stock.

Bill, in law, a security for money under the hand, and sometimes the seal, of the debtor. It is of two sorts, a single bill without a penalty, or a bill with a penalty, called a penal bill; which last is all one with what we call a bond or obligation, only it has not a condition.

Bill denotes also a declaration, in writing, expressing either some wrong the complainant has suffered by the defendant, or else a fault that the party complained of has committed against some law or statute of the realm.

This bill is sometimes exhibited to justices at the general assizes, by way of indictment, or referred to others having jurisdiction;

but more especially is addressed to the lord-chancellor, for inconscionable wrongs done. It contains the thing or fact complained of, the damage sustained, and a petition or process against the defendant for redress; and is used both in criminal and civil cases. In a criminal case, the words BILLA VERA are indorsed by the grand jury upon a presentment, thereby signifying, that they find the same made with probable evidence, and on that account worthy of further consideration.

BILL *in parliament*, a paper containing propositions, offered to the Houses to be passed by them, and then presented to the King to pass into a law. To bring a bill into the House, if the relief sought by it is of a private nature, it is first necessary to prefer a petition; which must be presented by a member, and usually sets forth the grievance desired to be remedied. This petition (when founded on facts that may be in their nature disputed) is referred to a committee of members, who examine the matter alleged, and accordingly report it to the House; and then (or, otherwise, upon the mere petition) leave is given to bring in the bill. In public matters, the bill is brought in upon motion made to the House, without any petition at all. The persons directed to bring in the bill present it in a competent time to the House, drawn out on paper, with a multitude of blanks, or void spaces, where any thing occurs that is dubious, or necessary to be settled by the Parliament itself, (such, especially, as the precise date of times, the nature and quantity of penalties, or of any sums of money to be raised); being, indeed, only the skeleton of the bill. In the House of Lords, if the bill begins there, it is (when of a private nature) referred to two of the judges, who examine and report the state of the facts alleged, to see that all necessary parties consent, and to settle all points of technical propriety. This is read a first time, and, at a convenient distance, a second time; and, after each reading, the Speaker opens to the House the substance of the bill, and puts the question, whether it shall proceed any farther? The introduction of the bill may be originally opposed, as the bill itself may, at either of the readings; and, if the opposition succeeds, the bill must be dropped for that session; as it must also, if opposed with success, in any of the subsequent stages. After the second reading, it is committed; that is, referred to a committee: which is either selected by the House, in matters of small importance, or else, upon a bill of consequence, the House resolves itself into a committee of the whole House. A committee of the whole House is composed of every member; and, to form it, the Speaker quits the chair, (another member being appointed chairman) and may sit and debate as a private member. In these committees, the bill is debated clause by clause, amendments made, the blanks filled up, and sometimes the bill entirely new modelled. After it has gone through the committee, the chairman reports it to the House, with such amendments as the committee have made; and then the House considers the whole bill again, and the question is repeatedly put upon every clause and amendment. When the House has agreed, or disagreed, to the amendments of the committee, and sometimes added new amendments of its own, the bill is then ordered to be engrossed, or written in a strong gross hand, on one or more long rolls (or presses) of parchment, sewed together. When this is finished, it is read a third time, and amendments are sometimes then made to it; and if a new clause be added, it is done by tacking a separate piece of parchment on the bill, which is called a ryder. The Speaker then again opens the contents; and, in holding it up in his hands, puts the question, whether the bill shall pass? If this is agreed to, the title to it is then settled; which used to be a general one for all the acts passed in the session, till in the fifth year of Henry VIII. distinct titles were introduced for each chapter. After this, one of the members is directed to carry it to the Lords, and desire their concurrence; who, attended by several more, carries it to the bar of the House of Peers, and there delivers it to their Speaker, who comes down from the woolsack to receive it. It there passes through the same forms as in the other House (except engrossing, which is already done); and, if rejected, no more notice is taken, but it passes *sub silentio*, to prevent unbecoming altercations; but if it is agreed to, the Lords send a message by two masters in chancery, (or sometimes two of the judges) that they have agreed to the same; and the bill remains with the Lords if they have made no amendments to it; but if any amendments are made, such amendments are sent down with the bill to receive the concurrence of the Commons. If the Commons disagree to the amendments, a conference usually follows be-

tween members deputed from each House; who, for the most part, settle and adjust the difference; but if both houses remain inflexible, the bill is dropped. If the Commons agree to amendments, the bill is sent back to the Lords by one of the members, with a message to acquaint them therewith. The same forms are observed, *mutatis mutandis*, when the bill begins in the House of Lords. But when an act of grace, or pardon, is passed, it is first signed by his Majesty, and then read once only in each of the Houses, without any new engrossing, or amendment. And when both Houses have done with any bill, it always is deposited in the House of Peers, to wait the royal assent; except in the case of a bill of supply, which after receiving the concurrence of the Lords is sent back to the House of Commons. The royal assent may be given two ways; 1. In person; when the King comes to the House of Peers, in his crown and royal robes, and sending for the Commons to the bar, the titles of all the bills that have passed both houses are read, and the King's answer is declared by the clerk of the parliament in Norman French: a badge it must be owned (now the only one remaining) of conquest; and which one could wish to see fall into total oblivion; unless it be reserved as a solemn memento to remind us that our liberties are mortal, having been once destroyed by a foreign force. If the King consents to a public bill, the clerk usually declares, "Le roy le veut." "The King wills it so to be," if to a private bill, "Soit fait comme il est desire;" "Be it as it is desired." If the King refuses his assent, it is in the gentle language of "Le roy s'avisera;" "The King will advise upon it." When a bill of supply is passed, it is carried up and presented to the King by the Speaker of the House of Commons, and the royal assent is thus expressed; "Le roy remercie ses loyal subjects, accepte leur benevolence, et aussi le voit;" "The King thanks his loyal subjects, accepts their benevolence, and wills it so to be." In case of an act of grace, which originally proceeds from the crown, and has the royal assent in the first stage of it, the clerk of the parliament thus pronounces the gratitude of the subject: "Les Prelats, Seigneurs, et Commons, en ce present parliament assemblees, au nom de touts vous autres subjects, remercient tres humblement votre Majeste, et prient a Dieu vous donner en sante bone vie et longue;" "The Prelates, Lords, and Commons, in this present parliament assembled, in the name of all your other subjects, most humbly thank your Majesty, and pray to God to grant you in health long to live."

2. By the stat. 33 Hen. III. c. 21, the King may give his assent by letters patent under his great seal, signed with his hand, and notified in his absence to both Houses assembled together in the High House. And when the bill has received the royal assent in either of these ways, it is then, and not before, a statute or act of parliament. This statute or act is placed among the records of the kingdom; there needing no formal promulgation to give it the force of a law, as was necessary by the civil law with regard to the emperor's edicts; because every man in Britain is, in judgment of law, party to the making of an edict of parliament, being present thereat by his representatives. However, a copy thereof is usually printed at the King's press for the information of the whole land. And formerly, before the invention of printing, it was used to be published by the sheriff of every county; the King's writ being sent to him at the end of every session, together with a transcript of all the acts made at that session, commanding him, "ut statuta illa, et omnes articulos in eisdem contentos, in singulis locis ubi expedire viderit, publice proclamari, et firmiter teneri et observari faciat." And the usage was to proclaim them at his county court, and there to keep them, that whoever would might read or take copies thereof; which custom continued till the reign of Henry VII. An act of parliament thus made is the exercise of the highest authority that this kingdom acknowledges upon earth. It hath power to bind every subject in the land, and the dominions thereunto belonging; nay, even the King himself, if particularly named therein. And it cannot be altered, amended, dispensed with, suspended, or repealed, but in the same forms, and by the same authority of parliament: for it is a maxim in law, that it requires the same strength to dissolve as to create an obligation. It is true, it was formerly held that the King might in many cases dispense with penal statutes; but now by statute 1 Wil. and M. st. 2, c. 2, it is declared, that the suspending, or dispensing with laws by regal authority, without consent of parliament, is illegal. See ACTS.

BILLARDIERA, in botany, a genus of the Pentandria Monogynia class and order. Petals five, alternating with the leaflets of the calyx; stigma simple; no nectary; ber-

ries superior; many-seeded. One species, found at New Holland.

BILLET, in heraldry, a bearing in form of a long square. They are supposed to represent pieces of cloth of gold or silver, but Guilim thinks they represent a letter sealed up; and other authors take them for bricks.

BILLET *wood*, small wood for fuel, cut three feet and four inches long, and seven inches and a half in compass; the assize of which is to be inquired of by justices.

BILLETTING, in military affairs, is the quartering of soldiers in the houses of a town or village.

BILLIARDS, an ingenious kind of game, played on a rectangular table, with little ivory balls, which are driven into hazards or holes, according to certain rules of the game. The table on which the game is played is generally about twelve feet long and six feet wide, or rather in the exact form of an oblong; it is covered with fine green cloth, and surrounded with cushions to prevent the balls rolling off, and to make them rebound. There are six holes, nets, or pockets: these are fixed at the four corners, and in the middle opposite to each other to receive the balls, which when put into these holes or pockets, are called hazards. The making of a hazard, that is, putting the adversary's ball in, at the usual game reckons for two in favour of the player. The game is played with sticks called maces, or with cues; the first consists of a long straight stick, with a head at the end, and are the most powerful instruments of the two: the cue is a thick stick diminishing gradually to a point of about half an inch diameter; this instrument is played over the left hand, and supported by the fore-finger and thumb. It is the only instrument in vogue abroad, and is played with amazing address by the Italians and some of the Dutch; but in England the mace is the prevailing instrument, which the foreigners hold in contempt, as it requires not near so much address to play the game with, as when the cue is made use of; but the mace is preferred for its peculiar advantage, which some professed players have artfully introduced, under the name of trailing, that is, following the ball with the mace to such a convenient distance from the other ball as to make it an easy hazard. The degrees of trailing are various, and undergo different denominations amongst the connoisseurs at this game; *viz.* the shove, the sweep, the long stroke, the trail, and the dead trail, or turn up, all which secure an advantage to a good player, according to their various gradations: even the butt end of the cue becomes very powerful, when it is made use of by a good trailer.

Rules generally observed at the common or usual game:—1. For the lead, the balls must be put at one end, and the player must strike them against the farthermost cushion, in order to see which will be nearest the cushion that is next to them. 2. The nearest to the cushion is to lead and choose the ball if he pleases. 3. The leader is to place his ball at the nail, and not to pass the middle pocket; and if he holes himself in leading, he loses the lead. 4. He who follows the leader must stand within the corner of the table, and not place his ball beyond the nail. 5. He who plays upon the running ball loses one. 6. He who touches the ball twice, and moves it, loses one. But these two rules are seldom or never enforced, especially in England. 7. He who does not hit his adversary's ball loses one. 8. He who touches both balls at the same time, makes a foul stroke, in which case if he should hole his adversary, nothing is gained by the stroke; but if he should put himself in he loses two. 9. He who holes both balls loses two. 10. He who strikes upon his adversary's ball and holes himself loses two. 11. He who plays at the ball without striking it and holes himself loses three. 12. He who strikes both balls over the table loses two. 13. He who strikes his ball over the table, and does not hit his adversary's ball loses three. 14. He who retains the end of his adversary's stick when playing, or endeavours to baulk his stroke loses one. 15. He who plays another's ball or stroke without leave loses one. 16. He who takes up his ball, or his adversary's without leave loses one. 17. He who stops either ball when running loses one; and being near the hole loses two. 18. He who blows upon the ball when running loses one, and if near the hole loses two. 19. He who shakes the table when the ball is running loses one. 20. He who strikes the table with the stick, or plays before his turn loses one. 21. He who throws the stick upon the table and hits the ball loses one. 22. If the ball stand upon the edge of the hole, and after being challenged it fall in, it is nothing, but must be put up where it was before. 23. If any person not being one of the players stops a ball, the ball must

stand in the place where it was stopped. 24. He who plays without a foot upon the floor, and holds his adversary's ball, gets nothing for it, but loses the lead. 25. He who leaves the game before it is ended loses it. 26. Any person may change his stick in play. 27. If any difference arises between players, he who marks the game, or the majority of the company must decide it. 28. Those who do not play must stand from the table and make room for the players. 29. If any person lays any wager and does not play, he shall not give advice to the players upon the game.

Different kinds of games played at billiards.—Besides the common winning game, which is twelve up, there are several other kinds of games, *viz.* the losing game, the winning and losing, choice of balls, bricole, carambole, Russian carambole, the barhole, the one-hole, the four-game, and hazards: but on these it is not necessary to enlarge.

BINARY *arithmetic*, that wherein unity, or 1 and 0, are only used. This was the invention of Mr. Leibnitz, who shews it to be very expeditious in discovering the properties of numbers, and in constructing tables; and Mr. Dangecourt, in the "History of the Royal Academy of Sciences," gives a specimen of it concerning arithmetical progressionals; where he shews that, because in binary arithmetic only two characters are used, therefore the laws of progression may be more easily discovered by it than by common arithmetic. All the characters used in binary arithmetic are 0 and 1, and the cypher multiples every thing by 2, as in the common arithmetic by 10. Thus, 1 is one; 10, two; 11, three; 100, four; 101, five; 110, six; 111, seven; 1000, eight; 1001, nine; 1010, ten; which is built on the same principles with common arithmetic. The author, however, does not recommend this method for common use, because of the great number of figures required to express a number; and adds, that if the common progression were from 12 to 12, or from 16 to 16, it would be still more expeditious.

BIND-*weed.* See Convolvulus.

BINOMIAL, in algebra, a root consisting of two members connected by the sign $+$ or $-$. Thus, $a + b$ and $8 - 3$ are binomials, consisting of the sums and differences of these quantities.

The powers of any binomial are found by a continual multiplication of it by itself. For example, the cube or third power of $a + b$, will be found by multiplication to be $a^3 + 3a^2b + 3ab^2 + b^3$; and if the powers of $a - b$ are required they will be found the same as the preceding, only the terms in which the exponent of b is an odd number will be found negative. Thus, the cube of $a - b$ will be found to be $a^3 - 3a^2b + 3ab^2 - b^3$, where the second and fourth terms are negative, the exponent of b being an odd number in these terms. In general, the terms of any power of $a - b$ are positive and negative by turns.

It is to be observed that in the first term of any power of $\overline{a+b}$, the quantity a has the exponent of the power required, that in the following terms the exponents of a decrease gradually by the same differences, *viz.* unit, and that in the last terms it is never found. The powers of b are in the contrary order; it is never found in the first term, but its exponent in the second term is unit; in the third term its exponent is 2; and thus its exponent increases till in the last term it becomes equal to the exponent of the power required.

As the exponents of a thus decrease, and at the same time those of b increase, the sum of their exponents is always the same, and is equal to the exponent of the power required. Thus, in the sixth power of $a + b$, *viz.* $a^6 + 6a^5b + 15a^4b^2 + 20a^3b^3 + 15a^2b^4 + 6ab^5 + b^6$, the exponents of a decrease in this order 6, 5, 4, 3, 2, 1, 0; and those of b increase in the contrary order 0, 1, 2, 3, 4, 5, 6. And the sum of their exponents in any term is always 6.

In general, therefore, if $a + b$ is to be raised to any power m, the terms without their coefficients will be a^m, $a^{m-1}b$, $a^{m-1}b^2$, $a^{m-3}b^3$, $a^{m-4}b^4$, $a^{m-5}b^5$, &c. continued till the exponent of b become equal to m.

The coefficients of the respective terms will be 1; m; $m \times \frac{m-1}{2}$; $m \times \frac{m-1}{2} \times \frac{m-2}{3}$; $m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4}$; $m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times \frac{m-4}{5}$, &c. continued until you have one coefficient more than there are units in m.

It follows therefore by these rules, that $\overline{a+b}^m = a^m + ma^{m-1}b + m \times \frac{m-1}{2} \times a^{m-2}b^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times a^{m-3}b^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times a^{m-4}b^4 +$, &c. which is the binomial or

general theorem for raising a quantity consisting of two terms to any power m.

The same general theorem will also serve for the evolution of binomials, because to extract any root of a given quantity is the same thing as to raise that quantity to a power whose exponent is a fraction that has its denominator equal to the number that expresses what kind of root is to be extracted. Thus, to extract the square root of $a+b$, is to raise $a+b$ to a power whose exponent is $\frac{1}{2}$. Now, $\overline{a+b}^{m}$ being found as above; supposing $m=\frac{1}{2}$, you will find $\overline{a+b}^{\frac{1}{2}} = a^{\frac{1}{2}} + \frac{1}{2} \times a^{-\frac{1}{2}} b + \frac{1}{2} \times -\frac{1}{4} \times a^{-\frac{3}{2}} b^2 + \frac{1}{2} \times -\frac{1}{4} \times -\frac{1}{2} a^{-\frac{5}{2}} b^3 +$, &c. $= a^{\frac{1}{2}} + \frac{b}{2a^{\frac{1}{2}}} - \frac{b^2}{8a^{\frac{3}{2}}} + \frac{b^3}{16a^{\frac{5}{2}}}$, —, &c.

To investigate this theorem, suppose n quantities, $x+a$, $x+b$, $x+c$, &c. multiplied together; it is manifest that the first term of the product will be x^n, and that x^{n-1}, x^{n-2}, &c. the other powers of x will all be found in the remaining terms, with different combinations of a, b, c, d, &c.

Let $\overline{x+b}.\overline{x+c}.\overline{x+d}.$&c. $= x^{n-1} + Px^{n-2} + Qx^{n-3} +$ &c. and $\overline{x+a}.\overline{x+b}.\overline{x+c}.\overline{x+d}.$&c. $= x^n + Ax^{n-1} + Bx^{n-2} +$ &c. then $x^n + Ax^{n-1} + Bx^{n-2} +$ &c. and $\overline{x+a} \times \overline{x^{n-1} + Px^{n-2} + Qx^{n-3} + \text{\&c.}}$ or,

$$\left.\begin{array}{l} x^n + Px^{n-1} + Qx^{n-2} + \text{\&c.} \\ \quad + ax^{n-1} + aPx^{n-2} + \text{\&c.} \end{array}\right\} \text{are the same series;}$$

therefore, $A = P + a$, $B = Q + aP$, &c. that is by introducing one factor, $x+a$, into the product, the coefficient of the second term is increased by a, and by introducing $x+b$ into the product, that coefficient is increased by b, &c. therefore the whole value of A is $a+b+c+d+$ &c. Again, by the introduction of one factor, $x+a$, the coefficient of the third term, Q, is increased by aP, *i. e.* by a multiplied by the preceding value of A, or by $a \times \overline{b+c+d+\text{\&c.}}$ and the same may be said with respect to the introduction of every other factor; therefore upon the whole,

$$\begin{aligned} B = {} & a.\overline{b+c+d+\text{\&c.}} \\ & + b.\overline{c+d+\text{\&c.}} \\ & + c.\overline{d+\text{\&c.}} \end{aligned}$$

In the same manner,

$$\begin{aligned} C = {} & a.b.\overline{c.+d+\text{\&c.}} \\ & + a.c.\overline{d+\text{\&c.}} \\ & + b.c.\overline{a+\text{\&c.}} \end{aligned}$$

and so on; that is, A is the sum of the quantities a, b, c, &c. B is the sum of the products of every two; C is the sum of the products of every three, &c. &c.

Let $a = b = c = d =$ &c. then A, or $a+b+c+d+$ &c. $= na$; $= ab + ac$B $+ bc +$ &c. $= a^2 \times$ the number of combinations of a, b, c, d, &c. taken two and two, $= n.\frac{n-1}{2}a^2$; in the same manner it appears that $C = n.\frac{n-1}{2}.\frac{n-2}{3}a^3$, &c. And $\overline{x+a}.\overline{x+b}.\overline{x+c}.$&c. to n factors $= \overline{x+a}|^n$; therefore $\overline{x+a}|^n = x^n + nax^{n-1} + n.\frac{n-1}{2}a^2x^{n-2} + n.\frac{n-1}{2}.\frac{n-2}{3}a^3x^{n-3} +$ &c.

This proof applies only to those cases in which n is a whole positive number; but the rule extends to those cases in which n is negative or fractional.

Ex. 1. $\overline{a+x}|^8 = a^8 + 8a^7x + 28a^6x^2 + 56a^5x^3 + 70a^4x^4 + 56a^3x^5 + 28a^2x^6 + 8ax^7 + x^8$.

Ex. 2. $\overline{1+x}|^n = 1 + nx + n.\frac{n-1}{2}x^2 + n.\frac{n-1}{2}.\frac{n-2}{3}x^3 +$ &c.

Ex. 3. $\overline{a^2+x^2}|^n = a^{2n} + na^{2n-2}x^2 + n.\frac{n-1}{2}a^{2n-4}x^4 +$ &c.

If either term of the binomial be negative, its odd powers will be negative, and consequently the signs of the terms, in which those odd powers are found, will be changed.

Ex. 4. $\overline{a-x}|^8 = a^8 - 8a^7x + 28a^6x^2 - 56a^5x^3 + 70a^4x^4 - 56a^3x^5 + 28a^2x^6 - 8ax^7 + x^8$.

Ex. 5. $\overline{a^2-x^2}|^n = a^{2n} - na^{2n-2}x^2 + n.\frac{n-1}{2}a^{2n-4}x^4 -$ &c.

If the index of the power to which a binomial is to be raised, be a whole positive number, the series will terminate, because the coefficient $n.\frac{n-1}{2}.\frac{n-2}{3}.$&c. will become nothing when it is continued to $\overline{n+1}$ factors. In all other cases the number of terms will be indefinite.

When the index is a whole positive number, the coefficients of the terms taken

backward, from the end of the series, are respectively equal to the coefficients of the corresponding terms taken forward from the beginning.

Thus, in the first example, where $a+x$ is raised to the 8^{th} power, the coefficients are 1, 8, 28, 56, 70, 56, 28, 8, 1.

In general, the coefficient of the $\overline{n+1}^{th}$ term is $\frac{n\,.\,\overline{n-1}\,.\,\overline{n-2}\,.....3\,.\,2\,.\,1}{1\,.\,2\,.\,3......\overline{n-2}\,.\,\overline{n-1}\,.\,n}=1.$

The coefficient of the n^{th} term is $\frac{n\,.\,\overline{n-1}\,.\,\overline{n-2}....3\,.\,2\,.}{1\,.\,2\,.\,3....\overline{n-2}\,.\,\overline{n-1}}=n;$ of the $\overline{n-1}^{th}$ term, $\frac{n\,.\,\overline{n-1}\,.\,\overline{n-2}....3\,.}{1\,.\,2\,.\,3.....\overline{n-2}}=\frac{n\,.\,\overline{n-1}}{1\,.\,2}$, &c.

The sum of the coefficients $1+n+n\,.\,\frac{n-1}{2}+$ &c. is 2^n.

For if $x=a=1$, then $\overline{x+a}|^n=\overline{1+1}|^n=2^n=1+n+n\,.\,\frac{n-1}{2}+$&c.

Since $\overline{x+a}|^n=x^n+n\,a\,x^{n-1}+n\,.\,\frac{n-1}{2}\,a^2\,x^{n-2}+$&c.

And $\overline{x-a}|^n=x^n-n\,a\,x^{n-1}+n\,.\,\frac{n-1}{2}\,a^2\,x^{n-2}-$&c.

By addition, $\overline{x+a}|^n+\overline{x-a}|^n=2\,.\,x^n+2\,.\,n\,.\,\frac{n-1}{2}\,a^2\,x^{n-2}+$&c.

Or $\frac{\overline{x+a}|^n+\overline{x-a}|^n}{2}=x^n+n\,.\,\frac{n-1}{2}\,a^2\,x^{n-2}+$&c.

By subtracting one series from the other, $\frac{\overline{x+a}|^n-\overline{x-a}|^n}{2}=n\,a\,x^{n-1}+n\,.\,\frac{n-1}{2}\,.\,\frac{n-2}{3}\,a^3\,x^{n-3}+$&c.

The trinomial $a+b+c$ may be raised to any power by considering two terms as one factor, and proceeding as before.

Thus, $a+\overline{b+c}|^n=a^n+n\,.\,\overline{b+c}\,.\,a^{n-1}+n\,.\,\frac{n-1}{2}\,.\,\overline{b+c}|^2\,.\,a^{n-2}+$&c. and the powers of $b+c$ may be determined by the binomial theorem.

BIOGRAPHY, a very entertaining and instructive species of history, containing the life of some remarkable person or persons.

Lord Bacon regrets, that the lives of eminent men are not more frequently written: for, adds he, though kings, princes, and great personages be few; yet there are many other excellent men, who deserve better than vague reports and barren elogies.

Biography, or the art of describing and writing lives, is a branch or species of history, in many respects as useful and important as that of history itself; inasmuch as it represents great men more distinctly, unencumbered with associates: and descending into the detail of their actions and characters, their virtues and failings, we obtain a more particular, and, of course, a more interesting acquaintance with individuals than general history allows. A writer of lives may, and ought, to descend to minute circumstances and familiar incidents. He is expected to give the private, as well as the public life of those whose actions he records; and it is from private life, from familiar, domestic, and apparently trivial occurrences, that we often derive the most accurate knowledge of the real character.

The subjects of biography are not only the lives of public or private persons, who have been eminent and beneficial to the world, but those also of persons notorious for their vice and profligacy, which may serve, when justly characterised, as warnings to others, by exhibiting the fatal consequences which, sooner or later, generally follow licentious practices. As for those who have exposed their lives, or devoted their time and talents for the service of their fellow-creatures, it is but a debt of gratitude to perpetuate their memories, by making posterity acquainted with their merits and usefulness. In the lives of public persons, their public characters are principally, but not solely, to be regarded; the world is interested in the minutest actions of great men, and their examples both as public and private characters, may be made subservient to the well-being and prosperity of society.

It has been a matter of dispute among the learned, whether any one ought to write his own history. There are instances both ancient and modern that may be adduced as precedents for the practice: and the reason assigned for it is, that no man can be so much the master of the subject as the person himself: but, on the other hand, it is a very difficult task for any one to write an impartial history of his own actions. Plutarch mentions two cases in which it is allowable for a man to commend

himself, and to be the publisher of his own merits; which are, when the doing of it may be of considerable advantage either to himself or to others. Notwithstanding this high authority, the former case is unquestionably liable to great objections, because a man is to be the judge in his own cause, and therefore very liable to exceed the limits of truth when his own interests are concerned, and when he wishes to render himself conspicuous for virtue or talents. The ancients, however, had a peculiar method of diverting the reader's attention from themselves, when they had occasion to record their own actions, and of thus rendering what they said less invidious, which was, by speaking of themselves in the third person. Among the moderns a practice has been introduced, which cannot be too strongly reprobated, though sanctioned by men of great talent, integrity, and real worth, namely, of making the memoirs of themselves the vehicle of abuse of their contemporaries; every one of whom would, no doubt, be able to give a very different, and perhaps plausible reason, for the several actions which the biographer has undertaken to scrutinize and condemn.

Dr. Priestley has constructed and published a "Biographical Chart," of which our plate is given as a specimen. This chart represents the interval of time between the year 1200 before the Christian æra, and 1800 after Christ, divided by an equal scale into centuries. It contains about 2000 names of persons, the most distinguished in the annals of fame, the length of whose lives is represented by lines drawn in proportion to their real duration, and terminated in such a manner as to correspond to the dates of their births and deaths. These names are distinguished into several classes by parallel lines running the whole length of the chart, the contents of each division being expressed at the end of it. The chronology is noted in the margin, on the upper side, by the year before and after Christ, and on the lower by the same æra, and also by the succession of such kings as were most distinguished in the whole period. See Plate BIOGRAPHY.

For a more full account we refer to Dr. Priestley's description which accompanies the chart; from which we shall make a short extract, that cannot fail to entertain the reader.

"Laborious and tedious as the compilation of this work has been (vastly more so than my first conceptions represented it to me), a variety of views were continually opening upon me during the execution of it, which made me less attentive to the labour. As these views agreeably amuse the mind, and may, in some measure, be enjoyed by a person who only peruses the chart, without the labour of compilation, I shall mention a few of them in this place.

"It is a peculiar kind of pleasure we receive, from such a view as this chart exhibits, of a great man, such as Sir Isaac Newton, seated, as it were, in the circle of his friends and illustrious contemporaries. We see at once with whom he was capable of holding conversation, and in a manner (from the distinct view of their respective ages) upon what terms they might converse. And though it be melancholy, it is not unpleasing, to observe the order in which we here see illustrious persons go off the stage, and to imagine to ourselves the reflections they might make upon the successive departure of their acquaintance or rivals.

"We likewise see, in some measure, by the names which precede any person, what advantages he enjoyed from the labours and discoveries of others; and, by those which follow him, of what use his labours were to his successors.

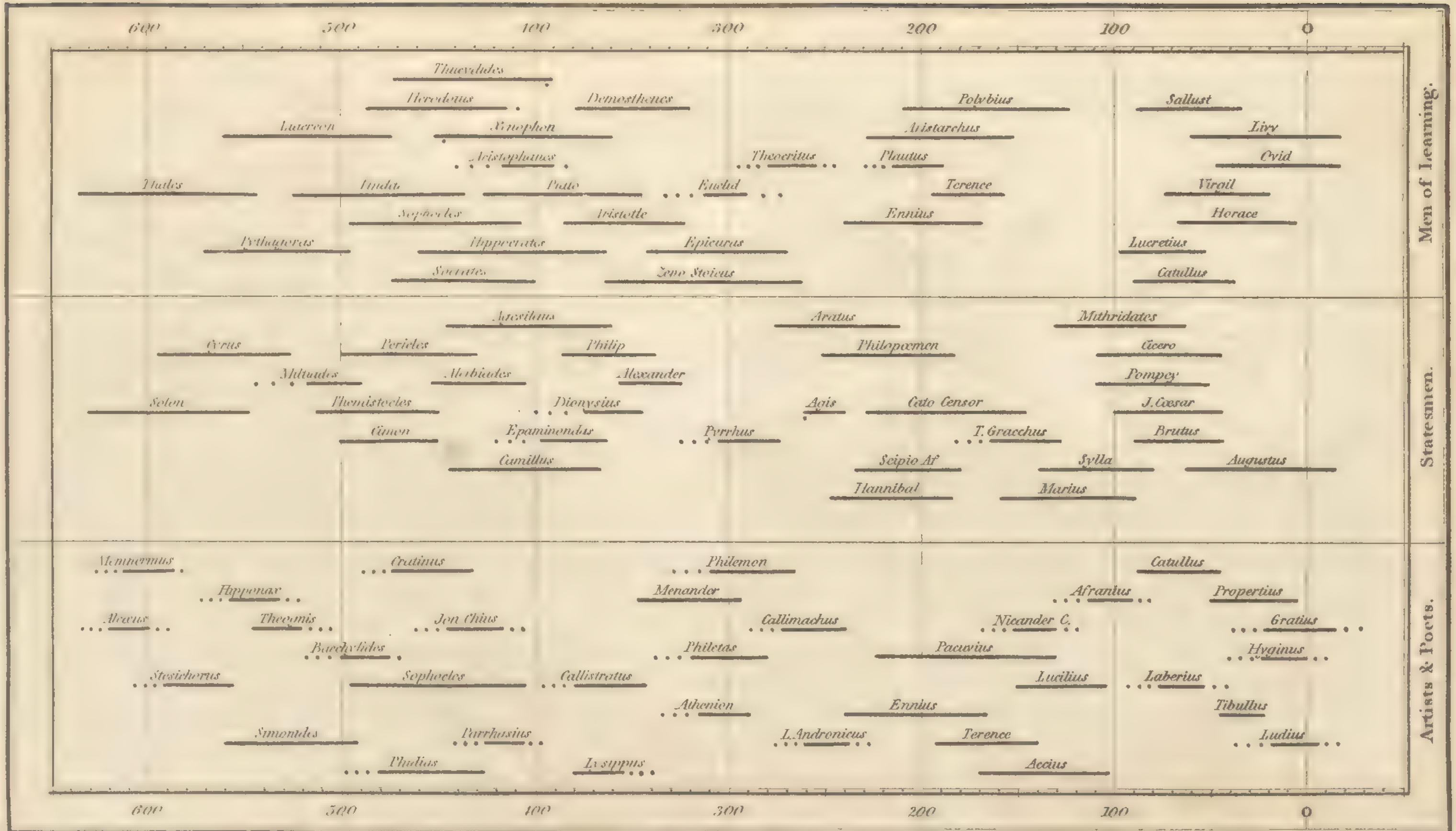
"By the several void spaces between such groups of great men, we have a clear idea of the great revolutions of all kinds of science, from the very origin of it; so that the thin and void places in the chart are, in fact, no less instructive than the most crowded, in giving us an idea of the great interruptions of science, and the intervals at which it hath flourished. The state of all the divisions appropriated to men of learning, is, for many centuries before the revival of letters in this western part of the world, exactly expressed by this following line of Virgil:

Apparent rari nantes in gurgite vasto.

But we see no void spaces in the division of statesmen, heroes, and politicians. The world hath never wanted competitors for empire and power, and least of all in those periods in which the sciences and the arts have been the most neglected.

"But the noblest prospect of this nature is suggested by a view of the crowds of names in the divisions appropriated to the arts and sciences in the two last centuries. Here all the classes of renown, and, I may add, of merit, are full; and a hundred times as many might have been admitted, of equal attainments in knowledge with their

BIOGRAPHY.



Published Feb.y 4, 1808 by Longman Hurst, Rees, & Orme, Paternoster Row, London.

Cooper sculp.

predecessors. This prospect gives us a kind of security for the continual propagation and extension of knowledge; and that, for the future, no more great chasms of men really eminent for knowledge will ever disfigure that part of the chart of their lives which I cannot draw, or ever see drawn. What a figure must science make, advancing as it now does, at the end of as many centuries as have elapsed since the Augustan age!"

BIPED, in zoology, an animal furnished with only two legs. Men and birds are bipeds. Apes occasionally walk on their hind legs, and seem to be of this tribe; but that is not a natural position for them, and they rest upon all their legs, like other quadrupeds. The jerboas are also of the latter description, jumping and leaping on their hind legs, but resting on the fore legs likewise.

BIQUADRATIC *power*, in algebra, the fourth power or squared square of a number, as 16 is the biquadratic power of 2; for 2×2 is 4, and 4×4 is equal to 16.

BIQUADRATIC *root of a number*, is the square root of its square root: thus the biquadratic root of 81 is 3; for the square root of 81 is 9, and the square root of 9 is 3.

BIQUADRATIC *equation*, an equation where the unknown quantity of one of the terms has four dimensions.

Any biquadratic equation may be conceived as generated by the multiplication of four simple equations. Thus, if $x = a$, $x = b$, $x = c$, $x = d$, or $x - a = 0$, $x - b = 0$, $x - c = 0$, $x - d = 0$; then will $x - a \times x - b \times x - c \times x - d = 0$, beget a biquadratic equation. Or it may be formed of two quadratic equations, as $\overline{x^2 + b\,x + c} \times \overline{x^2 + d\,x + e} = 0$; or, lastly, it may be produced from the multiplication of one cubic and one simple equation, as $\overline{x - a} \times \overline{x^3 + c\,x^2 + d\,x + e} = 0$. For an account of the resolution of biquadratic equations see EQUATIONS.

BIQUINTILE, an aspect of the planets, when they are 144 degrees from each other.

BIRCH *tree*. See BETULA.

BIRD, in zoology. See AVES.

BIRD-*catching*, the art of taking birds or wild fowl, whether for food, for the pleasure of their song, or for their destruction, as pernicious to the husbandman, &c. The methods are by bird-lime, nets, decoys, &c. In the suburbs of London are several weavers and other tradesmen, who, during the months of October and March, get their livelihood by an ingenious, and, we may say, a scientific method of bird-catching, which is totally unknown in other parts of Great Britain. The reason of this trade being confined to so small a compass arises from there being no considerable sale of singing birds, except in the metropolis: as the apparatus for this purpose is also heavy, and at the same time must be carried on a man's back, it prevents the bird-catchers going to more than three or four miles distance.

This method of bird-catching must have been long practised, as it is brought to a most systematical perfection, and is attended with a very considerable expense. The nets are a most ingenious piece of mechanism; they are generally twelve yards and a half long, and two yards and a half wide; and no one, on bare inspection, would imagine, that a bird, who is so very quick in all its motions, could be catched by the nets flapping over each other, till he becomes an eye-witness of the pullers seldom failing. The wild birds fly, as the bird-catchers term it, chiefly during the month of October, and part of September and November, as the flight in March is much less considerable than that of Michaelmas. It is to be noted also, that the several species of birds of flight do not make their appearance precisely at the same time, during the months of September, October, and November. The pippet, a small species of lark, for example, begins to fly about Michaelmas; and then the woodlark, linnet, goldfinch, chaffinch, greenfinch, and other birds of flights succeed, all of which are not easily to be caught, or in any numbers at any other time, and more particularly the pippet and the woodlark. These birds, during the Michaelmas and March flights, are chiefly on the wing from day-break to noon, though there is afterwards a small flight from two till night; but this however is so inconsiderable, that the bird-catchers always take up their nets at noon. The bird-catcher generally carries with him five or six linnets, of which more are caught than any singing bird, two goldfinches, two greenfinches, one woodlark, one redpoll, yellowhammer, titlark, and aberdevine, and perhaps a bullfinch; these are placed at small distances from the nets, in little cages. He has besides what are called flur-birds, which are placed within the nets, are raised upon the flur, or moveable perch, and gently let down at the time the wild bird approaches them. These generally

consist of the linnet, the goldfinch, and the greenfinch, which are secured to the flur by what is called a brace or bandage, a contrivance which secures the birds without doing any injury to their plumage. When the bird-catcher hath laid his nets, he disposes of his call-birds at proper intervals. It must be owned that there is most malicious joy in these call-birds, to bring the wild ones into the same state of captivity; which may likewise be observed with regard to the decoy ducks. See DECOY.

Their sight and hearing infinitely excel that of the bird-catcher. The instant that the wild birds are perceived, notice is given by one to the rest of the call-birds, (as it is by the first hound that hits on the scent to the rest of the pack) after which follows the same sort of tumultuous ecstasy and joy. The call-birds, while the bird is at a distance, do not sing as a bird does in a chamber; they invite the wild ones by what the bird-catchers call short jerks, which, when the birds are good, may be heard at a great distance. The ascendency by this call or invitation is so great, that the wild bird is stopped in its course of flight; and, if not already acquainted with the nets, lights boldly within 20 yards of perhaps three or four bird-catchers, on a spot which otherwise it would not have taken the least notice of. Nay, it frequently happens, that if half a flock only are caught, the remaining half will immediately afterwards light in the nets, and share the same fate; and should only one bird escape, that bird will suffer itself to be pulled at till it is caught; such a fascinating power have the call-birds.

The nightingale is not a bird of flight, in the sense the bird-catchers use this term. Like the robin, wren, and many other singing birds, it only moves from hedge to hedge, and does not take the periodical flights in October and March.

The persons who catch these birds, make use of small trap-nets, without call-birds; and are considered as inferior in dignity to other bird-catchers, who will not rank with them. The arrival of the nightingale is expected by the trappers in the neighbourhood of London, the first week in April: at the beginning, none but cocks are taken; but in a few days the hens make their appearance, generally by themselves, though sometimes a few males come along with them. The latter are distinguished from the females not only by their superior size, but by a great swelling of their vent, which commences on the first arrival of the hens. They are caught in a net-trap, the bottom of which is surrounded with an iron ring; the net itself is rather larger than a cabbage-net. When the trappers hear or see them, they strew some fresh mould under the place, and bait the trap with a meal-worm from the baker's shop. Ten or a dozen nightingales have been thus caught in a day.

The common way of taking larks, of which so many are used at our tables, is in the night, with those nets which are called trammels. These are usually made of 36 yards in length, and about six yards over, with six ribs of packthread, which at the ends are put upon two poles of about 16 feet long, and made lesser at each end. These are to be drawn over the ground by two men, and every five or six steps the net is made to touch the ground, otherwise it will pass over the birds without touching them, and they will escape. When they are felt to fly up against the net, it is clapped down, and then all are safe that are under it. The darkest nights are properest for this sport; and the net will not only take larks, but all other birds that roost on the ground, among which are woodcocks, snipes, partridges, quails, fieldfares, and several others.

In the depth of winter, people sometimes take great numbers of larks by nooses of horse hair. The method is this: take 100 or 200 yards of packthread; fasten at every six inches a noose made of double horse hair; at every 20 yards the line is to be pegged down to the ground, and so left ready to take them. The time to use this is when the ground is covered with snow, and the larks are to be allured to it by some white oats scattered all the way among the nooses. They must be taken away as soon as three or four are hung, otherwise the rest will be frighted; but though the others are scared away just where the sportsman comes, they will be feeding at the other end of the line, and the sport may be thus continued for a long time.

Those caught in the day are taken in clap-nets of 15 yards length, and two and a half in breadth, and are enticed within the reach by means of bits of looking-glass, fixed in a piece of wood, and placed in the middle of the nets, which are put in a quick whirling motion by a string the larker commands; he also makes use of a decoy lark. These nets are used only till the 14th of November; for the larks will not dare, or frolic in the air, except in fine sunny wea-

ther; and, of course, cannot be inveigled into the snare. When the weather grows gloomy, the larker changes his engine, and makes use of a trammel-net, twenty-seven or twenty-eight feet long, and five broad; which is put on two poles, eighteen feet long, and carried by men under each arm, who pass over the fields, and quarter the ground as a setting dog: when they hear or feel a lark hit the net, they drop it down, and so the birds are taken.

But the most singular species of bird-catching is on the Holm of Ness a vast rock severed from the isle of Ness by some unknown convulsion, and only about sixteen fathoms distant. It is of the same stupendous height as the opposite precipice, with a raging sea between; so that the intervening chasm is of matchless horror. Some adventurous climber reaches the rock in a boat, gains the height, and fastens several stakes on the small portion of earth which is to be found on the top; correspondent stakes are placed on the edge of the correspondent cliffs: a rope is fixed to the stakes on both sides, along which a machine, called a cradle, is contrived to slide; and, by the help of a small parallel cord, fastened in like manner, the adventurer wafts himself over, and returns with his booty.

The manner of bird-catching, in the Feroe islands, is very strange and hazardous. Necessity compels mankind to wonderful attempts. The cliffs which contain the objects of their search are often two hundred fathoms in height, and are attempted from above and below. In the first case, the fowlers provide themselves with a rope eighty or one hundred fathoms in length. The fowler fastens one end about his waist and between his legs, recommends himself to the protection of the Almighty, and is lowered down by six others, who place a piece of timber on the margin of the rock, to preserve the rope from wearing against the sharp edge. They have besides a small line fastened to the body of the adventurer, by which he gives signals that they may lower or raise him, or shift him from place to place. The last operation is attended with great danger, by the loosening of the stones, which often fall on his head, and would infallibly destroy him, was he not protected by a strong thick cap; but even that is found unequal to save him against the weight of the larger fragments of rock. The dexterity of the fowlers is amazing; they will place their feet against the front of the precipice, and dart themselves some fathoms from it, with a cool eye survey the places where the birds nestle, and again shoot into their haunts. In some places the birds lodge in deep recesses: the fowler will alight there, disengage himself from the rope, fix it to a stone, and at his leisure collect the booty, fasten it to his girdle, and resume his pendulous seat. At times he will again spring from the rock, and in that attitude, with a fowling net placed at the end of a staff, catch the old birds which are flying to and from their retreats. When he has finished his dreadful employment he gives a signal to his friends above, who pull him up, and share the hard-earned profit. The feathers are preserved for exportation; the flesh is partly eaten fresh; but the greater portion dried for winter's provision.

The fowling from below has its share of danger. The party goes on the expedition in a boat; and when it has attained the base of the precipice, one of the most daring, having fastened a rope about his waist, and furnished himself with a long pole with an iron hook at one end, either climbs or is thrust up by his companions, who place a pole under his breech, to the next footing spot he can reach. He, by means of the rope, brings up one of the boat's crew; the rest are drawn up in the same manner, and each is furnished with his rope and fowling-staff. They continue their progress upwards, in the same manner, till they arrive at the region of birds; and wander about the face of the cliff in search of them. They then act in pairs; one fastens himself to the end of his associate's rope, and in places where birds have nestled beneath his footing, he permits himself to be lowered down, depending for his security on the strength of his companion, who has to haul him up again; but it sometimes happens, that the person above is overpowered by the weight, and both inevitably perish. They fling the fowl into the boat, which attends their motions, and receives the booty. They often pass seven or eight days in this tremendous employment, and lodge in the crannies which they find in the face of the precipice.

Birds are likewise caught in traps of various kinds; and frequently by nooses of hairs. In this way great numbers of wheatears are annually taken on the various downs of England, particularly in Sussex. Small holes are dug by the shepherds in the ground, in each of which is placed a noose,

Whenever a cloud obscures the sun, these timid birds seek for shelter under a stone, or creep into any holes that present themselves; and they are thus ensnared by the nooses which fasten around their necks. Woodcocks and snipes are taken likewise by nooses of horse hair placed along their paths, in marshes and moist grounds. Wild ducks, in all their varieties, are taken in vast numbers every winter on our coasts, by means of decoys. See DECOY.

Grouse and partridges are taken by means of nets, either at night when resting on the ground, by observing where they alight, and, when settled, drawing a net over that part of the field; or, in the day, a very steady dog is used to point at them. The attention of the birds being thus fixed, two persons, drawing the two extremities of a large net, pass it over them, and thus secure a whole pack of grouse, or covey of partridges at once.

Pheasants are sometimes taken by night, by holding flaming sulphur under the trees on which they are observed to perch, the suffocating effluvia of which makes them fall senseless.

BIRD *lime.* The vegetable principle to which is given the name of bird-lime, was first examined by Vauquelin, who found it possessed of properties different from every other. It was found collected on the epidermis of a plant brought to Europe by Michaud, and called robinia viscosa, constituting a viscid substance, which made the fingers adhere to the young twigs. From the late analysis of bird-lime by Bouillon la Grange, it is obvious that it owes its peculiar properties to the presence of an analogous substance, which indeed constitutes the essential part of that composition. Hence the reason of the name of bird-lime to the principle itself. 1. Natural bird-lime (or that which exudes spontaneously from plants) possesses the following properties: its colour is green; it has no sensible taste or smell; is extremely adhesive; softens by the heat of the fingers, and sticks to them with great obstinacy. When heated it melts, swells up, and burns with a considerable flame, leaving a bulky charcoal behind it. It does not dissolve in water; alcohol has but little action on it, especially when cold. By the assistance of heat it dissolves a portion of it; but in cooling, allows the greatest part to precipitate again. When exposed to the air it continues glutinous, never becoming hard and brittle like the resins. It combines readily with oils. Ether is its true solvent, dissolving it readily without the assistance of heat. The solution is of a deep green colour. The alkalies do not combine with it; the effect of the acids was not tried. These properties are sufficient to distinguish bird-lime from every other vegetable principle. 2. Artificial bird-lime is prepared from different substances in different countries. The berries of the misletoe are said to have been formerly employed. They were pounded, boiled in water, and the hot water poured off. At present bird-lime is usually prepared from the middle bark of the holly. The process followed in England is as follows: the bark is boiled in water seven or eight hours, till it becomes soft. It is then laid in quantities in the earth, covered with stones, and left to ferment or rot for a fortnight or three weeks. By this fermentation, it changes to a mucilaginous consistency. It is then taken from the pits, pounded in mortars to a paste, and well washed with river water. Its colour is greenish, its flavour sour, and its consistence gluey, stringy, and tenacious. Its smell is similar to that of linseed oil. When spread on a glass plate and exposed to the air and light it dries, becomes brown, loses its viscidity, and may be reduced to a powder; but when water is added to it, the glutinous property returns. It reddens vegetable blues. When gently heated it melts and swells, and emits an odour like that of animal oils. When heated on red hot coals, it burns with a lively flame, and gives out a great deal of smoke, leaving a white ash, composed of carbonate of lime, alumina, iron, sulphate, and muriate of potash. Weak acids soften bird-lime, and partly dissolve it; strong acids act with more violence. Sulphuric acid renders it black; and when lime is added to the solution, acetic acid and ammonia separate. Nitric acid cold has little effect; but when assisted by heat it dissolves the bird-lime; and the solution, when evaporated, leaves behind it a hard brittle mass. By treating this mass with nitric acid, a new solution may be obtained, which by evaporation yields malic and oxalic acids, and a yellow matter which possesses, several of the properties of wax. Cold muriatic acid does not act on bird-lime; hot muriatic acid renders it black. Bird-lime, when treated with oxymuriatic acid, becomes white, and is divided into hard compact masses, having unaltered bird-lime in their centre. This white substance may be pulverised; it is insoluble in water; does

not melt when heated; and when treated with nitric acid, it neither becomes yellow, nor does it yield resin. Acetic acid softens bird-lime, and dissolves a certain portion of it. The liquid acquires a yellow colour. Its taste is insipid. When carbonate of potash is dropped into this solution, no precipitate falls. By evaporation it yields a resinous-like substance. Some of the metallic oxides are reduced when heated with bird-lime. Litharge combines with it, and forms a kind of plaster. Alcohol of the specific gravity 0.817 dissolves bird-lime at a boiling heat. On cooling, it lets fall a yellow matter similar to wax. The filtered liquid is bitter, nauseous, and acid. Water precipitates a substance similar to resin. Sulphuric ether dissolves bird-lime readily, and in great abundance. The solution is greenish. When mixed with water, an oily substance separates, which has some resemblance to linseed oil. When evaporated, a greasy substance is obtained, having a yellow colour and the softness of wax.

Birds' *nests*, in cookery, the nest of a small Indian swallow, very delicately tasted, and frequently mixed among soups. On the sea coasts of China, at certain seasons of the year, there are seen vast numbers of these birds; they leave the inland-country at their breeding time, and come to build in the rocks, and fashion their nests out of a matter which they find on the shore, washed thither by the waves. The nature of this substance is scarcely yet ascertained. According to Kempfer, it is molluscæ or sea-worms; according to M. le Poivre, fish-spawn; according to Dalrymple, sea-weeds; and according to Linnæus, it is the animal substance frequently found on the beach, which fishermen call blubbers or jellies. The nests are of a hemispheric figure, and of the size of a goose's egg, and in substance much resemble the ichthyocolla or isinglass. The Chinese gather these nests, and sell them to all parts of the world; they dissolve in broths, &c. and make a kind of jelly of a very delicious flavour. These nests are found in great abundance in the island of Sumatra, particularly about Croe, near the south end of the island. Four miles up the river of that name is a large cave, where the birds build in vast numbers. The nests are distinguished into white and black; of which the first are by far more scarce and valuable, being found in the proportion of one only to twenty-five. The white sort sells in China at the rate of 1000 to 1500 Spanish dollars the pecul; the black is usually disposed of at Batavia for about 20 dollars the same weight, where it is chiefly converted into glue, of which it makes a very superior kind. The difference between the two has by some been supposed to be owing to the mixture of the feathers of the birds with the viscous substance of which the nests are formed; and this they deduce from the experiment of steeping the black nests for a short time in hot water, when they are said to become in a great degree white. When the natives prepare to take the nests, they enter the caves with torches, and forming ladders according to the usual mode, of a single bamboo notched, they ascend and pull down the nests, which adhere in numbers together, from the side and top of the rocks. They say that the more frequently and regularly the cave is stripped, the greater proportion of white nests they are sure to find, and that on this experience they often make a practice of beating down and destroying the old nests in larger quantities than they trouble themselves to carry away, in order that they may find white nests the next season in their room. The birds, during the building time, are seen in large flocks on the beach, collecting in their bills the foam which is thrown up by the surf, of which there is little doubt but they construct their nests, after it has undergone perhaps a preparation, from a commixture with their saliva, or other secretion with which nature has provided them for that purpose.

Birds, *singing*, are, the nightingale, blackbird, starling, thrush, linnet, lark, throstle, canary-bird, bulfinch, goldfinch, &c. See some very curious experiments and observations on the singing of birds, Phil. Trans. vol. lxiii. part ii. No. 31. Their first sound is called chirp, which is a single sound repeated at short intervals; the next call, which is a repetition of one and the same note; and the third sound is called recording, which a young bird continues to do for ten or eleven months, till he is able to execute every part of his song; and when he is perfect in his lesson, he is said to sing his song round. Their notes are no more innate than language in man; they all sing in the same key. The honourable author, Daines Barrington, has attempted to reduce their comparative merits to a scale; and to explain how they first came to have particular notes.

Birds, in heraldry, according to their several kinds, represent either the contemplative or active life. They are the em-

blems of liberty, expedition, readiness, swiftness, and fear. They are more honourable bearings than fishes, because they participate more of air and fire, the two noblest and highest elements, than of earth and water. Birds must be borne in coat-armour, as is best fitting the propriety of their natural actions of going, sitting, standing, flying, &c. Birds that are either whole footed, or have their feet divided, and yet have no talons, are said to be membered; but the cock, and all birds of prey with sharp and hooked beaks and talons, for encounter or defence, are termed armed. In the blazoning of birds, if their wings be not displayed, they are said to be borne close; as, he beareth an eagle, &c. close.

BIRTH. See MIDWIFRY.

BIRTH, or BIRTHING, in the sea-language, a convenient place to moor a ship in; also a due distance observed by ships lying at anchor, or under sail; and a proper place aboard for a mess to put their chests, &c. is called the birth of that mess.

BISCUIT, *sea*, is a sort of bread much dried, to make it keep for the service of the sea. It was formerly baked twice, or oftener, and prepared six months before the embarkation. It will keep good a whole year.

The process of biscuit-baking for the British navy is as follows, and it is equally simple and ingenious. The meal, and every other article, being supplied with much certainty and simplicity, large lumps of dough, consisting merely of flour and water, are mixed up together; and as the quantity is so immense as to preclude, by any common process, a possibility of kneading it, a man manages, or, as it is termed, rides a machine, which is called a horse. This machine is a long roller, apparently about four or five inches in diameter, and about seven or eight feet in length. It has a play to a certain extension, by means of a staple in the wall, to which is inserted a kind of eye, making its action like the machine by which they cut chaff for horses. The lump of dough being placed exactly in the centre of a raised platform, the man sits upon the end of the machine, and literally rides up and down throughout its whole circular direction, till the dough is equally indented; and this is repeated till it is sufficiently kneaded; at which times, by the different positions of the lines, large or small circles are described, according as they are near to or distant from the wall.

The dough in this state is handed over to a second workman, who slices it with a prodigious knife; and it is then in a proper state for the use of those bakers who attend the oven. These are five in number; and their different departments are as well calculated for expedition and correctness, as the making of pins, or other mechanical employments. On each side of a large table, where the dough is laid, stands a workman; at a small table near the oven stands another; a fourth stands by the side of the oven, to receive the bread; and a fifth to supply the peel. By this arrangement the oven is as regularly filled, and the whole exercise performed in as exact time, as a military evolution. The man on the further side of the large table moulds the dough, having previously formed it into small pieces, till it has the appearance of muffins, although rather thinner, and which he does two together, with each hand; and as fast as he accomplishes this task, he delivers his work over to the man on the other side of the table, who stamps them with a docker on both sides with a mark. As he rids himself of this work, he throws the biscuits on the smaller table next the oven, where stands the third workman, whose business is merely to separate the different pieces into two, and place them immediately under the hand of him who supplies the oven, whose work of throwing, or rather chucking, the bread upon the peel, must be so exact, that if he looked round for a single moment, it is impossible he should perform it correctly. The fifth receives the biscuit on the peel, and arranges it in the oven; in which duty he is so very expert, that though the different pieces are thrown at the rate of seventy in a minute, the peel is always disengaged in time to receive them separately.

As the oven stands open during the whole time of filling it, the biscuits first thrown in would be first baked, were there not some counteraction to such an inconvenience. The remedy lies in the ingenuity of the man who forms the pieces of dough, and who, by imperceptible degrees, proportionably diminishes their size, till the loss of that time, which is taken up during the filling of the oven, has no more effect to the disadvantage of one of the biscuits than to another.

So much critical exactness and neat activity occur in the exercise of this labour, that it is difficult to decide whether the

palm of excellence is due to the moulder, the marker, the splitter, the chucker, or the depositor; all of them, like the wheels of a machine, seeming to be actuated by the same principle. The business is to deposit in the oven seventy biscuits in a minute; and this is accomplished with the regularity of a clock; the clack of the peel, during its motion in the oven, operating like the pendulum.

The biscuits thus baked are kept in repositories, which receive warmth from being placed in drying lofts over the ovens, till they are sufficiently dry to be packed into bags, without danger of getting mouldy; and when in such a state, they are then packed into bags of a hundred weight each, and removed into storehouses for immediate use.

The number of bake-houses belonging to the victualling-office at Plymouth are two, each of which contains four ovens, which are heated twenty times a day, and in the course of that time bake a sufficient quantity of bread for 16,000 men.

The granaries are large, and well constructed; when the wheat is ground, the flour is conveyed into the upper stories of the bake-houses, whence it descends through a trunk in each immediately into the hands of the workmen.

The bake-house belonging to the victualling-office at Deptford consists of two divisions, and has twelve ovens, each of which bakes twenty shoots daily (Sundays excepted); the quantity of flour used for each shoot is two bushels, or 112 pounds, which baked produce 102 pounds of biscuit. Ten pounds are regularly allowed on each shoot for shrinkage, &c. The allowance of biscuit in the navy is one pound for each man *per* day, so that one of the ovens at Deptford furnishes bread daily for 2,040 men.

BISCUTELLA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ Cruciformes. Essential character; silicle compressed flat, rounded above and below, two-lobed; calyx, leaflets gibbous at the base. There are 6 species; of which B. auriculata, in a wild state rises about a foot in height, but, in a garden, grows nearly two feet high, dividing into several branches; the flowers are produced at the end of the branches, in loose panicles, and are of a pale yellow colour; the nectareous gland is very large, and, consequently, the calyx is bagged out very much at bottom. Native of the south of France and Italy.

BISERRULA, in botany, a genus of the Diadelphia Decandria class and order. Natural order Papilionacæ, or Leguminosæ. Essential character; legume two-celled, flat; partition contrary. There is but one species; *viz.* B. pelecinus, bastard hatchet vetch, an annual plant, which grows naturally in Italy, Sicily, Spain, and the South of France.

BISHOP, a prelate, or person consecrated for the spiritual government of a diocese.

Whether the distinction of bishops from mere priests or presbyters was settled in the apostolical age, or introduced since, is much controverted. It is certain, that in the New Testament the names of bishops and priests are used indiscriminately; but tradition, the fathers, and the apostolical constitutions make a distinction. From this last consideration bishops are conceived as the highest ecclesiastical dignities, the chief officers in the hierarchy, or economy of church-government, as the fathers and pastors of the faithful, the successors of the apostles, and, as such, the superiors of the church of Christ.

Upon the vacancy of a bishop's see in England the king grants his conge d'elire to the dean and chapter, to elect the person whom, by his letters missive, he hath appointed; and if they do not make the election in twenty days they are to incur a premunire. The dean and chapter having made their election accordingly, the archbishop, by the king's direction, confirms the bishop, and afterwards consecrates him by imposition of hands, according to the form laid down in the Common Prayer Book. Hence we see that a bishop differs from an archbishop in this, that an archbishop with bishops consecrates a bishop, as a bishop with priests consecrates a priest; other distinctions are, that an archbishop visits a province, as a bishop a diocese; that an archbishop convocates a provincial synod, as a bishop a diocesan one; and that the archbishop has canonical authority over all the bishops of his province, as a bishop has over the priests of his diocese.

The jurisdiction of a bishop of the church of England consists in collating benefices, granting institutions, commanding inductions, taking care of the profits of vacant benefices for the use of the successors, consecrating churches and chapels, ordaining priests and deacons, confirming after bap-

tism, granting administrations, and taking probates of wills; these parts of his function depend upon the ecclesiastical law. By the common law he is to certify to the judges concerning legitimate and illegitimate births and marriages; and to his jurisdiction, by the statute law, belongs the licensing of physicians, surgeons, and school masters, and the uniting of small parishes, which last privilege is now peculiar to the Bishop of Norwich.

All bishops of England are peers of the realm, except the Bishop of Man, and as such sit and vote in the House of Lords; they are barons in a three-fold manner, *viz.* feudal, in regard to the temporalities annexed to their bishoprics; by writ, as being summoned by writ to parliament; and lastly, by patent and creation: accordingly they have the precedence of all other barons, vote as barons and bishops, and claim all the privileges enjoyed by the temporal lords, excepting that they cannot be tried by their peers, because, in cases of blood, they themselves cannot pass upon the trial, for they are prohibited by the canons of the church to be judges of life and death.

BISHOP'S *court*, an ecclesiastical court, held in the cathedral of each diocese, the judge whereof is the bishop's chancellor, who judges by the civil and canon law; and if the diocese be large he has his commissaries in remote parts, who hold what they call consistory courts for matters limited to them by their commission.

BISHOPRIC, the district over which a bishop's jurisdiction extends, otherwise called a diocese.

In England there are twenty-four bishoprics and two archbishoprics; in Scotland none at all; in Ireland eighteen bishoprics and four archbishoprics; and in Popish countries they are still more numerous.

BISMUTH, one of the brittle and easily fused metals. The ores of this metal are very few in number, and occur chiefly in Germany. This, in some measure, accounts for the ignorance of the Greeks and Arabians, neither of whom appear to have been acquainted with bismuth. The German miners, however, seem to have distinguished it at a pretty early period, and to have given it the name of bismuth; for Agricola describes it under that name as well known in Germany, and considers it as a peculiar metal. The miners gave it also the name of tectum argenti; and appear to have considered it as silver beginning to form, and not yet completed. Mr. Pott collected in his dissertation on bismuth every thing respecting it contained in the writings of the alchymists. Becher seems to have been the first chemist who pointed out some of its most remarkable properties. Bismuth is of a reddish white colour, and almost destitute both of taste and smell. It is composed of broad brilliant plates adhering to each other. The figure of its particles, according to Hauy, is an octahedron, or two four-sided pyramids, applied base to base. Its specific gravity is 9.82. When hammered cautiously, its density, as Muschenbroeck ascertained, is considerably increased. It is not therefore very brittle: it breaks, however, when struck smartly by a hammer, and consequently is not maleable. Neither can it be drawn out into wire. Its tenacity, from the trials of Muschenbroeck, appears to be such, that a rod $\frac{1}{18}$th of an inch in diameter is capable of sustaining a weight of nearly 29 *lbs*. When heated to the temperature of 476° it melts; and if the heat be much increased it evaporates, and may be distilled over in close vessels. When allowed to cool slowly, and when the liquid metal is withdrawn as soon as the surface congeals, it crystallizes in parallelopipeds, which cross each other at right angles. When kept melted at a moderate heat, it becomes covered with an oxide of a greenish grey or brown colour. In a more violent heat it is volatile, and may be sublimed in close vessels; but, with the access of air, it emits a blue flame, and its oxide exhales in a yellowish smoke, condensible by cold bodies. This oxide is very fusible; and is convertible by heat into a yellow transparent glass. Sulphuric acid acts on bismuth, and sulphurous acid is disengaged. A part of the bismuth is dissolved, and the remainder is changed into an insoluble oxide. Nitric acid dissolves bismuth with great rapidity. To one part and a half of nitric acid, at distant intervals, add one of bismuth, broken into small pieces. The solution is crystallizable. It is decomposed when added to water; and a white substance is precipitated, called magistery of bismuth, or pearl-white. This pigment is defective, inasmuch as it is liable to be changed by sulphuretted hydrogen, and by the vapours of putrifying substances in general. Muriatic acid acts on bismuth. The compound, when deprived of water by evaporation, is capable of being sublimed, and affords a soft salt, which deliquesces into what has been improperly called butter of bismuth. Bismuth is capable of forming the basis of a sympathetic ink.

The acid employed for this purpose must be one that does not act on paper, such as the acetic. Characters written with this solution become visible when exposed to sulphuretted hydrogen.

BISSECTION, in geometry, the division of a line, angle, &c. into two equal parts.

BISSEXTILE, or *leap-year*, a year consisting of 366 days, and happening every fourth year, by the addition of a day in the month of February, which that year consists of 29 days. And this is done to recover the 6 hours which the sun takes up nearly in his course more than the 365 days commonly allowed for it in other years.

The day thus added was by Julius Cæsar appointed to be the day before the 24th of February, which among the Romans was the 6th of the calends, and which on this occasion was reckoned twice; whence it was called the bissextile. By the statute *De anno bissextile*, 21 Hen. III. to prevent misunderstandings, the intercalary day and that next before it are to be accounted as one day.

To find what year of the period any given year is, divide the given year by 4, then if 0 remains it is leap year; but if any thing remain the given year is so many after leap year. But the astronomers concerned in reforming the calendar in 1582, by order of Pope Gregory XIII. observing that in 4 years the bissextile added 44 minutes more than the sun spent in returning to the same point of the ecliptic; and computing that in 133 years these supernumerary minutes would form a day; to prevent any changes being thus insensibly introduced into the seasons, directed that in the course of 400 years there should be three sextiles retrenched; so that every centesimal year, which is a leap year according to the Julian account, is a common year in the Gregorian account, unless the number of centuries can be divided by 4 without a remainder. So 1600 and 2000 are bissextile; but 1700, 1800, and 1900 are common years.

The Gregorian computation has been received in most foreign countries ever since the reformation of the calendar in 1582, excepting some northern countries, as Russia, &c. And by act of parliament passed in 1751, it commenced in all the dominions under the crown of Great Britain in the year following; it being ordered by that act that the natural day next following the 2nd of September should be accounted the 14th; omitting the intermediate 11 days of the common calendar. The supernumerary day in leap years being added at the end of the month February, and called the 29th of that month.

BISTOURY, in surgery, an instrument for making incisions, of which there are different kinds, some being of the form of a lancet, others straight and fixed in the handle like a knife, and others crooked with the sharp edge on the inside.

BISTRE, or BISTER, among painters, denotes glossy soot, pulverised and made into a kind of cakes with gum-water.

BIT, or BITTS, in ship-building, the name of two great timbers usually placed abaft the manger in the ship's loof, through which the cross-piece goes; the use of it is to belay the cable thereto while the ship is at anchor.

BITCH, the female of the dog kind. See CANIS.

BITTER, a sea term, signifying any turn of the cable about the bits, so as that the cable may be let out by little and little. And when a ship is stopped by a cable she is said to be brought up by a bitter. Also that end of the cable which is wound about the bits is called the bitter end of the cables.

BITTER *principal*. The bitter taste of certain vegetables appears to be owing to the presence of a peculiar substance, differing from every other in its chemical properties. It may be extracted from the wood of quassia, the root of gentian, the leaves of the hop, and several other plants, by infusing them for some time in cold water. The characters of this substance, originally described by Wether, have been attentively examined by Dr. Thomson, who enumerates them as follows. 1. When water thus impregnated is evaporated to dryness by a very gentle heat, it leaves a brownish yellow substance which retains a certain degree of transparency. For some time it continues ductile, but at last becomes brittle. Its taste is intensely bitter. 2. When heated it softens, swells, and blackens; then burns away without flaming much, and leaves a small quantity of ashes. 3. It is very soluble in water and in alcohol. 4. It does not affect blue vegetable colours. 5. It is not precipitated by the watery solution of lime, barytes, or strontites; nor is it changed by alkalies. 6. Tincture of galls, infusion of nut-galls, and gallic acid, produce no effect. 7. Of the metallic salts, nitrate of silver and acetate of lead are the only ones that throw it down. The precipitate by acetite of lead is very abundant; and

that salt, therefore, affords the best test for discovering the bitter principle when no other substances are present, by which also it is decomposed. From recent experiments of Mr. Hatchett, it appears that the bitter principle is formed, along with tan, by the action of nitric acid on indigo.

Bitter *salt, native,* in mineralogy, is of a greenish white, or smoke-grey colour. It occurs sometimes in earthy, sometimes in mass, and often in capillary crystals. When earthy it is without lustre, but when crystallised its lustre is between silky and vitreous. It consists of sulphate of magnesia, more or less mixed with iron and allumina, and probably some sulphat of allumina. It is found on the surface of decomposing argillaceous schistus, and sometimes of lime-stone.

BITTERN. See Ardea.

Bittern, in salt-works, the brine remaining after the salt is concreted: this they ladle off that the salt may be taken out of the pan, and afterwards put in again; when being farther boiled it yields more salt.

BITTERSPATH, in mineralogy, is greyish, or greenish white, passing into asparagus green. It occurs: 1. disseminated or crystallised in rhomboids, or perfect or truncated at the solid angles; 2. short, somewhat oblique, tetrahedral prisms, often bevelled at the edges; 3. compressed hexaedrons. It is composed of

Carbonate of lime...............	52
——— magnesia........	45
Oxide of iron and manganese	3
	100

BITUMEN, in chemistry. The term bitumen has often been applied by chemists to all the inflammable substances that occur in the earth; but this use of the word is now so far limited, that sulphur and millite are most commonly excluded. It would be proper to exclude amber likewise, and to apply the term to those fossil bodies only which have a certain resemblance to oily and resinous substances. Bituminous substances may be subdivided into two classes, namely, bituminous oils, and bitumens, properly so called. The first set possess nearly the properties of volatile oils, and ought, in strict propriety, to be classed with these bodies; but as the chemical properties of bitumens have not yet been investigated with much precision, it is deemed rather premature to separate them from each other. The second set possess properties peculiar to themselves. Only two species of bituminous oils have been hitherto examined by chemists. Others indeed have been mentioned; but their existence has not been sufficiently authenticated. These two species are called petroleum, and maltha, or sea-wax: the first is liquid, the second solid. See Petroleum and Maltha.

The true bituminous substances may be distinguished by the following properties:-- They are either solid, or of the consistence of tar: their colour is usually brown or black: they have a peculiar smell, or at least acquire it when rubbed: this smell is known by the name of the bituminous odour: they become electric by friction, though not insulated: they melt when heated, and burn with a strong smell, a bright flame, and much smoke: they are insoluble in water and alcohol, but dissolve most commonly in ether, and in the fixed and volatile oils: they do not dissolve in alkaline leys, nor form soap: acids have little action on them: the sulphuric scarcely any: the nitric, by long and repeated digestion, dissolves them, and converts them into a yellow substance, soluble both in water and alcohol, and similar to the product formed by the action of nitrous acid on resins. The bitumens at present known may be reduced to three; namely, asphaltum, mineral tar, and mineral caoutchouc. Bitumen has been found also united to a resinous compound, in a curious substance first accurately examined by Mr. Hatchett, to which he has given the name of retinasphaltum. United to charcoal in various proportions, it constitutes the numerous varieties of pit-coal, so much employed in this country as fuel. The asphaltum found in Albania is supposed to have constituted the chief ingredient of the Greek fire. Asphaltum is seldom absolutely pure; for when alcohol is digested on it, the colour of the liquid becomes yellow, and by gentle evaporation a portion of petroleum is separated. Mineral tar seems to be nothing else than asphaltum, containing a still greater proportion of petroleum. When alcohol is digested on it, a considerable quantity of that oil is taken up; but there remains a black fluid substance, like melted pitch, not acted upon by alcohol, and which therefore appears to possess the properties of asphaltum, with the exception of not being solid. By exposure to the air, it is said gradually to assume the state of asphaltum.

BIVALVES, one of the three general classes of shell-fish, comprehending all those,

the shells of which are composed of two pieces, joined together by a hinge.

The Linnæan genera of bivalve shells are the following fourteen:

Anomia	Mya
Arca	Mytillus
Astræa	Solen
Cardium	Spondylus
Chama	Tellina
Donax	Tillus
Mactra	Venus.

BIXA, in botany, a genus of Polyandria Monogynia class and order. Natural order of Columniferæ; Tiliacæ, Jussieu. Essential character: corolla ten-petalled; calyx five-toothed; capsule hispid, bivalve. B. ænellana is a shrub with an upright stem, eight or ten feet high, sending out many branches at the top, forming a regular head; these are garnished with heart-shaped leaves ending in a point; the flowers are produced in loose panicles, at the end of the branches, of a pale peach colour, having large petals. There is but one species which is a native both of the East and West Indies.

BLACK, something opake and porous, that imbibes the greatest part of the light that falls on it, reflects little or none, and therefore exhibits no colour. Bodies of a black colour are found more inflammable, because the rays of light falling on them are not reflected outwards, but enter the body and are often reflected and refracted within it, till they are stifled and lost. They are also found lighter, *cæteris paribus*, than white bodies, being more porous. It may be added, that clothes dyed of this colour wear out faster than those of any other, because their substance is more penetrated and corroded by the vitriol necessary to strike their dye, than other bodies are by the galls and alum which suffice for them. The inflammability of black bodies, and their disposition to acquire heat, beyond those of other colours, are easily evinced. Some appeal to the experiment of a white and black glove worn in the same sun; the consequence will be, a very sensibly greater degree of heat in the one hand than the other. Others allege the phenomena of burning-glasses, by which black bodies are always found to kindle soonest: thus, a burning-glass, too weak to have any visible effect at all upon white paper, will readily kindle the same paper rubbed over with ink.

Dr. Watson, the present Bishop of Landaff, covered the bulb of a thermometer with a black coating of India ink, in consequence of which the mercury rose ten degrees. Phil. Trans. vol. lxiii. Black clothes heat more, and dry sooner in the sun than white clothes. Black is therefore a bad colour for clothes in hot climates; but a fit colour for the linings of ladies' summer hats.

Black *act*, in law, so called from the devastations committed in Hampshire by persons in disguise, or with their faces blacked; to prevent which, it is enacted by 31 George II. c. 42, that persons hunting, armed, and disguised, and killing or stealing deer, or robbing warrens, &c. or setting fire to any house, barn, or wood, or shooting at any person, or sending anonymous letters, or letters signed with a fictitious name, demanding money, &c. or rescuing such offenders; are guilty of felony without benefit of clergy.

Black, *bone*, is made with the bones of oxen, cows, &c. and is used in painting; but is not so much esteemed as ivory-black.

Black, *currier's*, a black made with gall-nuts, sour beer, and old iron, termed the first black. The second black, which gives the gloss of the leather, is composed of gall-nuts, copperas, and gum arabic.

Black, *earth*, a sort of coals found in the ground, which the painters and limners use to paint in fresco, after it has been well ground.

There is also a black made with gall-nuts, copperas, or vitriol, such as common ink. And a black made with silver and lead, which serves to fill up the cavities of engraved things.

Black, *ivory*, otherwise called velvet-black, is burnt ivory, which becoming quite black, and being reduced to thin plates, is ground in water, and made into troches, to be used by painters, and by jewellers; who set precious stones to blacken the ground of the collets, and give the diamonds a teint or foil. In order to be good, it ought to be tender, friable, and thoroughly ground.

Black, *lamp*, the sooty smoke of rosin. There is some in powder and some in lumps, and is mostly brought from Sweden and Norway. It is used on various occasions, particularly for making the printers' ink, for which purpose it is mixed with oil of walnuts, or linseed, and turpentine, all boiled together.

Black *lead* has long been known under the name of plumbago, it is however properly denominated in the modern chemistry according to its component parts, a car-

buret of iron, it being compounded of 90 parts of carbon, and 10 iron. See IRON, where its properties will be described.

Black-lead is found in different countries, but the very best, and the fittest for making pencils is found at Borrowdale in Cumberland, where it is obtained in such plenty, that not only the whole Island of Great Britain, but the Continent of Europe may be said to be supplied from thence. Beside the application of this substance to the manufacture of pencils, it is made into retorts that will endure almost the strongest heat. The powder of black-lead is used in covering the straps for razors, and with it stoves, &c. are preserved from rust.

BLACK *rod, gentleman usher of*, in British customs, is chief gentleman to the King. He has also the keeping of the chapter-house door, when a chapter of the Order of the Garter is sitting; and in time of parliament attends on the House of Peers.

BLACKBURNIA, in botany, so called in honour of John Blackburne, Esq. and his daughter Anna, of Orford in Lancashire; a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-toothed; petals four, eliptic; anthers heart-shaped; germ conic; stigma simple; pericarp, berry, with a single seed. There is but one species, *viz.* bipinnata has the leaves alternate; abruptly pinnate, with two or three pairs of leaflets, which are opposite, quite entire, and very smooth; panicles axillary, smaller. It is in habit not unlike ptelea trifoliata, and whether it ought to be separated from that genus cannot be determined, till we are better acquainted with the fruit. It is a native of Norfolk Island.

BLACKWELLIA, in botany, a genus of the Dodecandria Pentagynia class and order. Calyx five-cleft, half superior; corol fifteen-petalled; capsules one celled, many-seeded. There are three species in the Asiatic islands.

BLADHIA, in botany, so named from Peter John Bladh, a Swede, a genus of the Pentandria Monogynia class and order. Essential character: calyx wheel-shaped, deciduous; berry containing one arilled seed. There are three species, all natives of Japan. B. of which japonica has a perennial root, with small fibres, a shrubby stem, flexuoses erect, very thinly branched, from four inches to a foot high. Flowers axillary; corolla white; sweet smelling.

BLADDER, a thin membranous substance, found in several parts of an animal, serving as a receptacle of some juice, or of some liquid excrement, as the urinary bladder, gall bladder, &c. See ANATOMY.

BLADE, in commerce, a slender piece of metal, designed for cutting: thus we meet with sword-blade, blade of a chissel, blade of a saw, &c.

BLÆRIA, in botany, a genus of the Tetrandria Monogynia class of plants, the flower of which is monopetalous and campanulated: the tube is cyclindric, of the length of the cup, and pervious: the limb is small, and divided into four oval reflex segments: the fruit is an oblong quadrangular capsule, with four cells, containing several roundish seeds. There are six species, all found at the Cape of Good Hope.

BLAIR (JOHN), an eminent chronologist, was educated at Edinburgh. Afterward, coming to London, he was for some time usher of a school in Hedge-lane. In 1754 he first published "The Chronology and History of the World, from the Creation to the year of Christ 1753;" illustrated in 56 tables. In 1755 he was elected a Fellow of the Royal Society, and in 1761 of the Society of Antiquaries. In 1756 he published a 2d edition of his "Chronological Tables;" and in 1768 an improved edition of the same, with the addition of 14 maps of ancient and modern geography, for illustrating the Tables of Chronology and History; to which is prefixed a "Dissertation on the Progress of Geography." In 1757 he was appointed chaplain to the Princess Dowager of Wales, and mathematical tutor to the Duke of York; whom he attended in 1763 in a tour to the continent, from which they returned the year after. Dr. Blair had successively several good church livings: as a prebendal stall at Westminster, the vicarage of Hinckley, and the rectory of Burton Coggles in Lincolnshire, all in 1761; the vicarage of St. Bride's in London, in 1771, in exchange for that of Hinckley; the rectory of St. John the Evangelist in Westminster, in 1776, in exchange for the vicarage of St. Bride's; in the same year the rectory of Horton near Colebrooke, Bucks. Dr. Blair died the 24th of June, 1782.

BLAKEA, in botany, so named from Martin Blake of Antigua, a genus of the Dodecandria Monogynia class and order. Essential character: calyx inferior, six-leaved; superior, entire; petals six; capsules six-celled, many-seeded. There are but two species, of which B. trinervia generally grows to the height of ten or fourteen feet;

but rises higher when it remains a climber, in which state it continues some time. It is one of the most beautiful productions of America. It supports itself for a time by the help of some neighbouring shrub or tree, but it grows gradually more robust, and at length acquires a pretty moderate stem, which divides into a thousand weakly declining branches, well supplied with beautiful rosy blossoms on all sides. It is a native of Jamaica, in cool moist shady places.

BLANCHING *of copper* is done various ways, so as to make it resemble silver. If it be done for sale, it is felony by 8 and 9 William III. ch. xxvi.

Blanching, in coinage, the operation performed on the planchets or pieces of silver, to give them the requisite lustre and brightness. They also blanch pieces of plate, when they would have them continue white, or have only some parts of them burnished.

Blanching, as it is now practised, is performed by heating the pieces on a kind of peel with a wood-fire, in the manner of a reverberatory: so that the flame passes over the peel. The pieces being sufficiently heated and cooled again, are put successively to boil in two pans, which are of copper: in these they put water, common salt, and tartar of Montpelier. When they have been well drained of this water in a copper sieve, they throw sand and fresh water over them; and when dry, they are well rubbed with towels.

Blanching, among gardeners, an operation whereby certain sallets, roots, &c. are rendered whiter than they would otherwise be. It is this: after pruning off the tops and roots of the plants to be blanched, they plant them in trenches about ten inches wide, and as many deep, more or less, as is judged necessary; as they grow up, care is taken to cover them with earth, within four or five inches of their tops: this is repeated, from time to time, for five or six weeks, in which time they will be fit for use, and of a whitish colour, where covered by the earth.

BLANK, in commerce, a void or unwritten place which merchants sometimes leave in their day-books or journals. It is also a piece of paper at the bottom of which a person has signed his name, the rest being void. These are commonly intrusted into the hands of arbiters, to be filled up as they shall think proper, to terminate any dispute or law-suit.

Blank *verse*, in the modern poetry, that composed of a certain number of syllables, without the assistance of rhyme. See Poetry.

BLASIA, in botany, a genus of the Cryptogamia Hepaticæ class and order. Male solitary; imbedded in the frond: female no calyx; capsule imbedded in the frond, oblique, one-celled, with a tubular mouth; seeds numerous. There is one species, a native of England.

BLASPHEMY, an indignity or injury offered to the Almighty, by denying what is his due, and of right belonging to him; or by attributing to the creature that which is due only to the creator.

Blasphemy, among the Jews, was punished by stoning the offender to death. With us, it is punishable at common law, by fine and pillory. And by a statute of William III. if any person shall, by writing or speaking, deny any of the persons in the Trinity, he shall be incapable of any office; and for the second offence, be disabled to sue in any actions, to be an executor, &c.

BLAST, in a general sense, denotes any violent explosion of air, whether occasioned by gunpowder, or by the action of a pair of bellows.

Blast, a disease in grain, trees, &c. The sugar-cane in the West Indies is very subject to a disease of this kind, occasioned perhaps by one or more species of the aphides. The disease is distinguished into the black and yellow: the latter is the most destructive. It consists of insects invisible to the naked eye, whose proper food is the juice of the cane, in search of which they wound the tender blades, and in the end destroy the whole.

BLASTING, a term used by miners for the tearing up rocks which lie in their way by the force of gunpowder. In order to do this, a long hole is made in the rock, which being charged with gunpowder, they fill it up; leaving only a touch-hole, with a match to fire the charge.

Blasting *of wood*, the rending in pieces logs of wood, such as roots of trees, &c. by means of gunpowder. A method has been lately described by Mr. Knight, which is simple, and easily effected. The instrument used is a screw, with a small hole drilled through its centre. The head of the screw is formed into two strong horns, for the more ready admission of the lever with which it is to be turned, and a wire, for the purpose of occasionally clearing the touch-hole. When a block of wood is to be broken, a hole is

to be bored with an augre to a proper depth, and a charge of gunpowder introduced. The screw is to be turned into the hole till it nearly touches the powder; a quick match is then to be put down the touch-hole till it reaches the charge. The quick match is eighteen inches long, to afford the operator an opportunity of retiring, after lighting it, to a place of safety: it is made by steeping a roll of twine or linen thread in a solution of saltpetre.

BLATTA, the *cock-roach*, in natural history, a genus of insects of the order Hemiptera. The generic characters are, head inflected; antennæ setaceous; wings flat, subcoriaceous; thorax flattish, orbicular, margined; feet formed for running; hornlets two over the tail. The insects of this genus, and their larvæ wander about by night, and secret themselves by day. They are fond of warmth, and haunt houses, devouring meal, and whatever provisions they can get at: they run with great celerity, and are destroyed by the fumes of charcoal. In hot climates they are a great pest to society, by not only devouring whatever they can get at, but some of the species leave a very unpleasant smell, which is apt to remain a considerable time on the articles which they have passed over. The largest of the genus is, as its name imports, the B. gigantea, a native of many of the warmer parts of Asia, Africa, and South America, of which the following account is given by Drury in his "Exotic Insects." "The cock-roach," says he, "are a race of pestiferous beings, equally noisome and mischievous to natives and strangers, but particularly to collectors. These nasty and voracious insects fly out in the evenings and commit monstrous depredations: they plunder and erode all kinds of victuals, drest and undrest, and damage all sorts of clothing, especially those which are touched with powder, pomatum, and similar substances; every thing made of leather, books, paper, and various other articles, which, if they do not destroy, at least they soil, as they frequently deposit a drop of their excrement where they settle, and some way or other by that means damage what they cannot devour. They fly into the flame of candles, and sometimes into the dishes; are very fond of ink and oil, into which they are apt to fall and perish. In this case they turn most offensively putrid, so that a man might as well set over the cadaverous body of a large animal, as write with the ink in which they have died. They often fly into persons' faces or bosoms, and their legs being armed with sharp spines, the pricking excites a sudden horror not easily described. In old houses they swarm by myriads, making every part filthy beyond description wherever they harbour, which in the day-time is in dark corners, behind all sorts of clothes, in trunks, boxes, and in short every place where they can lie concealed. In old timber and deal houses, when the family is retired at night to sleep, this insect, among other disagreeable properties, has the power of making a noise which very much resembles a pretty smart knocking with the knuckle upon the wainscotting. The B. gigantea, in the West Indies, is therefore frequently known by the name of the drummer. Three or four of these noisy creatures will sometimes be impelled to answer one another, and cause such a drumming noise, that none but those who are very good sleepers can rest for them. What is most disagreeable, those who have not gause curtains are sometimes attacked by them in their sleep: the sick and the dying have their extremities attacked, and the ends of the toes and fingers of the dead are frequently stripped, both of the skin and flesh. This insect is not at present known in Europe, though many of the other species, of which Gmelin enumerates 47, have been introduced by ships from the warmer regions, and are become nuisances in our houses. It has been supposed that the gigantea has been seen once at least in our own country, concerning which Mouffet writes: "I have heard from people worthy of credit, that one of the blattæ was found on the roof of Peterborough church, which was six times larger than the common blatta, and which not only pierced the skin of those who endeavoured to seize it, but bit so deep as to draw blood very copiously: it was as large as one's thumb, and being confined in the cavity of the wall, after two or three days it made its escape, unnoticed by any one." In Asia this species is as large as a good sized hen's egg. B. orientalis, or common black cock-roach, was found in America, but has long been naturalized in Europe: female with mere rudiments of wing-cases and wings: egg subcylindrical with a crenate ridge, and half as large as the abdomen. This is frequently met with in London and elsewhere under the name of black beetle. B. americana is native of America, and has of late years appeared in Europe, having been brought over in raw sugar. B. irrorata is

nearly as large as B. gigantea, and is a native of New Holland; head pale; front subferuginous; the hind margin brown; wing-cases with an abbreviated black line at the base.

BLAZONING, or BLAZONRY, in heraldry, the art of decyphering the arms of noble families. The word originally signified the blowing or winding of a horn, and was introduced into heraldry as a term denoting the description of things borne in arms, with their proper significations and intendments, from an ancient custom, the heralds, who were judges, had of winding an horn at justs and tournaments, when they explained and recorded the achievements of knights.

In blazoning a coat of arms, you must always begin with the field, and next proceed to the charge; and if there be many things borne in the field, you must first name that which is immediately lying upon the field. Your expressions must be very short and expressive, without any expletives, needless repetitions, or particles. Such terms for the colours must be used as are agreeable to the station and quality of the bearer. All persons beneath the degree of a noble must have their coats blazoned by colours and metals; noblemen by precious stones, and kings and princes by planets.

BLEACHING, in the arts, is a process that consists of a series of operations, partly chemical and partly mechanical, to which vegetable and animal fibres are subjected for the purpose of discharging their natural colour, and thus rendering them white, either before or after they have been manufactured. Now as almost all the articles of clothing are formed of vegetable or animal fibres, and as these are for the most part required to be made as white as possible, either to be worn in this state, or as preparatory to being dyed or printed, it is obvious that the art of bleaching is one of great importance. The substances upon which the bleacher is required to exercise his art are cotton, flax, hemp, wool, and silk. The three former being of vegetable origin require a somewhat similar treatment, which in many particulars differs from that which is applicable to the two latter.

The art of bleaching consists, not merely in discharging the colour of the thread, but likewise in removing the colouring matter itself, as otherwise a sensible shade would be regained. In the old method this was attained by alternate exposure of the thread or cloth to the action of light, humidity, and atmospheric air, and to an alkaline ley, the cloth being macerated in a solution of potash, exposed on the field, to the air and sun, and frequently sprinkled with water; and these alternate practices being continued until the bleaching was complete. In the new method, the action of the oxymuriatic acid is substituted for that of the light, air, and water; and it answers the same purpose by affording oxygen to the colouring matter, thus impairing the colour, and probably rendering the matter soluble in the alkaline solution.

At first this process was performed by exposing the cloth to the action of the pure acid in the state of gas. It was found, however, to act unequally on the cloth, the texture being injured in one part, while in another it was imperfectly whitened. The solution of it therefore in water was substituted, and even this requires to be considerably diluted. The bleaching liquor, according to the directions given by Berthollet, is prepared by putting six parts of black oxide of manganese and sixteen of muriate of soda into a glass, or earthen retort, or a leaden bottle, and pouring upon them twelve parts of sulphuric acid, diluted with nine of water. The retort, or bottle is connected by a tube with a receiver, designed to retain any common muriatic acid that may pass over; from this vessel another tube issues, which is inserted in a large wooden cask filled with water. The tube descends nearly to the bottom of the cask, so that the gas has to rise through the whole body of the water at the same time, the absorption of it is promoted by the motion of a circular frame placed in the middle of the cask, and which can be turned round at the top. The oxygenated acid is thus easily condensed. After the first disengagement of the gas has ceased, heat is applied to the retort by placing it in a sand bath, or if a leaden bottle be used, by placing it in a vessel of boiling water. So much water is used that the oxygenated acid is very weak; it requires to be stronger for coarse than fine cloth, and for linen than for cotton; the average quantity stated by Berthollet is 100 quarts for every pound of muriate of soda that has been used. The cloth to be bleached is prepared by macerating it in warm water for some hours, to take up what part of the colouring matter may be soluble. It is then boiled in an alkaline ley, prepared from 20 parts of water, and one part of the potash of com-

merce rendered more active by having been mixed with one third of lime. After sufficient boiling it is washed with water, and put into close wooden troughs, containing the oxygenated acid, in which it is allowed to macerate for 3 or 4 hours, pressing the cloth frequently, and exposing its surfaces to the action of the liquor. It is thus alternately exposed to the action of the alkaline ley and the oxygenated acid, till its colouring matter is completely extracted, or it is sufficiently bleached, which requires in general from 4 to 8 immersions, according to the nature and coarseness of the cloth, cotton requiring fewer immersions in the bleaching liquor than linen. The subsequent steps of the process are to rub the cloth strongly with soft soap in warm water. This renders the surface more smooth and uniform, and takes away the smell of the oxygenated acid, which otherwise remains a considerable time. The cloth is again washed, and is lastly immersed for a short time in water, in which, from a one-sixtieth to a one-hundreth part of sulphuric acid has been dissolved. The cloth thus acquires a much finer whiteness, from the sulphuric acid dissolving the remaining colouring matter which has resisted the action of the alkali and oxygenated acid, as well as a small quantity of iron and calcareous earth contained in all vegetable matter, or even deposited in the cloth from the alkaline leys. Lastly, the cloth is generally exposed to the air for some days, and watered, to carry off any remains of either of the acids, and to remove completely the odour of the oxygenated acid. The theory of the action of the oxygenated muriatic acid in bleaching is very simple, as stated by Berthollet. Its analogy to the common process by exposure to the air and light, he observes, is complete. The end obtained by either is the combination of oxygen with the colouring matter of the vegetable. By this combination the colour is nearly destroyed, and the matter on which it depends is at the same time rendered soluble in the alkaline solution. Hence the necessity of the alternate application of these two chemical agents; the one removing from the cloth what the other has rendered soluble, and which, although whitened, would regain part at least of its colour in time. Hence it is found, that the oxygenated muriatic acid is in this operation converted into common muriatic acid, and the alkaline solution is at length so loaded with colouring matter, that it becomes unfit to be used. The only difference between the two methods is, that in the one the oxygen is presented in a much more concentrated state than in the other, which facilitates the process, or renders it more rapid without injuring the strength of the fibre. At least, the only injury of this kind that can happen must arise from improper management; having used too strong an acid, or the not washing the cloth sufficiently after the process is finished. The greatest difficulty attending the use of oxymuriatic acid arose from its suffocating odour, which rendered it almost impossible to work with it in an open vessel, and any apparatus contrived to turn the cloth and expose fresh surfaces of it to the action of the liquid in close vessels has been found imperfect. The addition of an alkali to the liquid removes in a great measure the odour of the acid, or at least prevents its unpleasant effects; and although it at the same time diminishes to a certain extent its bleaching power, this is more than compensated for by the advantage. The quantity of alkali added amounts to about 1*lb.* of the potash or pearlash of commerce to the quantity of acid prepared from 4*lbs.* of muriate of soda. And to avoid the effervescence which would arise from the disengagement of the carbonic acid, during the combination of the oxymuriatic acid, the potash is deprived of it by the previous addition of lime, the alkaline solution after its operation being poured off clear.

Independently of the weakening of the power of the acid by this addition, a considerable expense was introduced by the use of the alkali; and it became an object of importance to the manufacturers of this country to substitute a cheaper substance which should have the same effect. Lime was tried at first in an imperfect manner, but at length with such improvements that it is now always used. The difficulty of using it arose from the insolubility of the lime in water, the quantity taken up being so inconsiderable, that the solution could have little effect in correcting the odour of the acid. A very important improvement, therefore, was that of using lime suspended in water, and kept in suspension by an agitation in a close vessel, into which the gas was transmitted. Its condensation was thus facilitated, and the compound which is formed with the lime being soluble in water, the undissolved or unsaturated lime was

allowed to subside, and the clear liquor was fit for the purpose of bleaching.

An improvement, however, of still more importance has been made by Mr. Tennant of Glasgow, and a patent obtained for it; *viz.* that of combining the oxymuriatic acid with dry lime, and dissolving a certain proportion of this compound in water to form a bleaching liquor. It perhaps could scarcely have been supposed that such a combination could have been formed, so as to retain the powers of the acid. But the trial has fully succeeded, and the advantages derived from it are important; the compound can be carried easily to a distance, and the manufacturer need not prepare it himself, which is always an advantage, especially where he does not work on a large scale. The combination is formed by introducing the oxymuriatic acid gas through leaden tubes into slaked lime, prepared from chalk, by which it is absorbed. Solutions of this are prepared of different strengths, according to the purposes to which they are to be applied, the strength being judged of by the hydrometer, and by the quantity requisite to destroy the colour of a diluted solution of indigo in sulphuric acid. The process of bleaching, as now performed by these liquors, differs little from that which has been already described as executed by the solution of the oxymuriatic acid alone in water. To these methods, however, is to be added the more recent discovery of bleaching by an alkali, assisted by watery vapour and a high temperature, and which, either alone or combined to a certain extent with the method by the oxymuriatic acid, is now practised with so much advantage. In this method, which has been long in use in some of the eastern countries, and of which notice was first given by Chaptal, the cloth or thread is impregnated with a solution of potash or soda, rendered active by the carbonic acid having been entirely abstracted from the alkali by lime; it is suspended loosely, and, with an extensive surface, in a close boiler, a quantity of the same solution being in the bottom, and heat is applied, the boiler being closed, with a safety valve in the cover, so that the vapour under pressure may receive a high temperature. It is kept in this situation for a number of hours. The thread or cloth when cold is washed, and either exposed on the field, or subjected to the action of the oxymuriatic acid in some of the forms under which it has been used. It is thus at once rendered perfectly white. The superiority of this method probably arises from the high temperature, and the solvent power of the watery vapour, favouring the action of the alkali on the colouring matter, while this vapour penetrates the fibres of the cloth so effectually, that the matter is in a great measure dissolved and removed.

The animal fibres that are subjected to the bleaching process are wool and silk. These cannot be treated in the same manner as vegetable substances: a strong alkaline ley will dissolve them, and oxymuriatic acid will both weaken them and turn them yellow. The colour of manufactured wool resides partly in its own oil, and partly in the greasy and mucilaginous applications which it receives in being prepared for the loom. Both the one and the other are easily got rid of, by the action of fuller's earth and soap in the process of fulling. Fuller's earth is a very fine-grained absorbent earth, which by itself is capable of mixing rather than combining with vegetable or animal oils, and rendering them miscible with water: its action is found, however, to be increased by the addition of soap; and woollen cloth being beat in a fulling-mill with hot water, and a proper mixture of earth and soap, or of soap alone, and afterwards well washed and dried in the air, receives all the bleaching which it requires, or is indeed capable of. It is then of a white colour, somewhat verging towards yellow: this last tinge may be made to disappear by the addition of a very small quantity of stone blue in the water in which the cloth is last washed, or by exposing it to the fumes of burning sulphur. By this latter method, however, it acquires a certain harshness of feel, and is apt to turn very yellow when washed with soap. Both the colour and harshness of raw silk depend entirely on a yellow varnish with which it is naturally covered. This varnish may be in part removed by long boiling in simple water. It is considerably more soluble in alcohol; but the most effectual and expeditious way of clearing is by putting it in a linen bag, and boiling it for some hours in a solution of white soap in water, then rincing it in clean water, and repeating the process till it is quite white, and exhibits the peculiar lustre of this beautiful substance. Some of the French chemists have endeavoured to lessen the consumption of soap, by proposing various substitutes; but nothing is so effectual and expeditious as the purest white soap, and the article itself is so valuable, as amply to repay this expense.

The oxymuriatic acid has also been used from its bleaching power in the manufacture of paper; either the linen rags from which the paper is to be made being blanched by it, or, what has been regarded as preferable, the pulp into which they are reduced being submitted to its action. This method, though once extensively practised in this country, has been relinquished by many of our paper-manufacturers, as it has been found, that in paper prepared with it, in the course of a few years the ink is altered, and its blackness even so much impaired, as to afford some reason for the suspicion that in time it will altogether fade; nor is this confined to writing ink, but has been observed even in printing ink. The effect is no doubt to be ascribed to a slight impregnation of the oxymuriatic acid; and this indeed can often be rendered perceptible by its odour, by breathing on paper which has been bleached in this manner. It might no doubt be removed by very careful washing of the pulp; but we have been informed by some intelligent paper manufacturers, that the additional labour which would be requisite for this would upon the whole render the method more expensive than the old one.

The process of bleaching by steam with an alkali at a high temperature, might probably be advantageously employed. A branch of the manufacture, however, in which the acid necessarily must be used, is that of discharging the colours from coloured rags, or to remove the ink from waste written paper. Even printed paper has been whitened by its agency, combined with that of an alkali, to remove the oily matter, and made to afford at least a coarser kind of paper. Chaptal applied it to the purpose of restoring the colour of old books or prints, the paper being whitened by a very dilute acid, which did not act sensibly on the printing ink.

Wax, reduced to thin plates, has been bleached by the oxymuriatic acid. The process succeeds best when the acid is used in the state of gas. Berthollet has announced a peculiar effect obtained from the action of oxymuriatic acid, that of giving the appearance of cotton to hemp or flax. The process consists in immersing the flax, prepared by boiling, and by an alkaline solution in oxymuriatic acid of a certain strength, for some time, and alternating this immersion repeatedly with the action of an alkaline ley.

BLECHNUM, in botany, a genus of the Cryptogamia Filices, or Ferns. There are six species, all of them natives of warm or hot countries, excepting B. virginicum, which will bear the open air of England. They are increased by parting the roots.

BENDE. See ZINC.

BLENNIUS, *blenny*, in natural history, a genus of fishes of the order Jugulares. The generic characters are, head sloping; body lengthened, sub-compressed, lubricous; gill membrane six-rayed; ventral fins two, three, or four-rayed, unarmed; anal fin distinct. There are two divisions; *viz.* A. head crested; B. head not crested; and according to Gmelin there are 18 species, though Dr. Shaw enumerates more. B. galerita, or crested blenny, inhabits the European ocean, is four or five inches long; its body is brown and spotted; the skin at the corner of the upper jaw loose, projecting; dorsal fin extending from the head almost to the tail; ventral fin small; vent under the ends of the pectoral fin. This fish is frequently found about the rocky coasts of Great Britain. B. ocellaris has above the eyes a single ray, and on the first dorsal fin a large black ocellate spot. It inhabits the Mediterranean Sea; is eight inches long; the body is without scales, dirty green, with olive streaks, rarely pale blue: the flesh is eatable, but in no great estimation. Although Linnæus and others have described this fish as having two dorsal fins, Block considers it as having in reality but one, the sinking in of the middle part being in some specimens much deeper than in others, seems to be the cause of this difference of opinion. B. saliens is a very small species, observed about the coasts of some of the southern islands, and particularly those of New Britain. It seems to be of a gregarious nature, and is seen swimming by hundreds, and flying as it were over the surface of the water, occasionally springing among the rocks. It is naturally formed for celerity in its movements, the pectoral fins being very large in proportion to the body. They are nearly of a circular form when expanded, and when contracted reach almost as far as the vent on each side. B. superciliosus has a small head, with large eyes, and silvery irides, and immediately over each eye is situated a small palmated crest, or appendage, divided into three segments. The body is covered with very small scales, and is of a yellow or gilded tinge, and marked with numerous and irregular spots of dusky red. The dorsal fin commences at the back part of the head, and is continued almost to the tail; but near its commence-

ment suddenly sinks, so as almost to give the appearance of a smaller anterior dorsal fin, separate from the longer one: the pectoral fins are of moderate size; the ventral ones didactyle, and rather long: the vent is situated in the middle of the abdomen, from which part the anal fin commences, and reaches as far as the tail. This species is found native in the Indian seas, grows to the length of about twelve inches, and is viviparous. There is, however, another species, denominated B. viviparus, which, like that just noticed, is distinguished by a particularity that takes place in but very few fishes, except those of the cartilaginous tribe; being viviparous, the ova hatching internally, and the young acquiring their perfect form before the time of birth. Not less than two, or even three hundred of these have been sometimes observed in a single fish. It might be imagined that so great a number, confined in so small a space, might injure each other by the briskness of their motions; but this is prevented by the curious disposition of fibres and cellules among which they are distributed, as well as by the fluid with which they are surrounded. When advanced far in its pregnancy, it is scarcely possible to touch the abdomen without causing the immediate exclusion of some of the young, which are instantly capable of swimming with great alertness. The B. viviparus is littoral fish, and is found about the coasts of the Mediterranean, and the Baltic and Northern Seas, and sometimes it enters the mouths of rivers. It feeds on the smaller fishes, &c. It is taken by the line and net; but is not estimated as food, as its bones acquire a greenish colour by boiling. See Plate II. Pisces: fig. 2.

BLIGHT, in agriculture, a general name for various distempers incident to corn and fruit trees. It affects them variously, the whole plant sometimes perishing by it, and sometimes only the leaves and blossoms, which will be scorched and shrivelled up, the rest remaining green and flourishing. Some have supposed that blights are produced by easterly winds, which bring vast quantities of insects' eggs along with them from distant places. These being lodged upon the surface of the leaves and flowers of fruit trees, cause them to shrivel up and perish. Mr. Knight, however, observes that blights are produced by a variety of causes, by insects, by an excess of heat or cold, of drought or moisture; for these necessarily derange and destroy the delicate organization of the blossoms.

The term blight is very frequently used by the gardener and farmer without any definite idea being annexed to it. If the leaves of their trees be eaten by the caterpillar, or contracted by the aphis; if the blossoms fall from the ravages of insects, or without any apparent cause, the trees are equally blighted; and if an east wind happen to have blown, the insects, or at least their eggs, whatever be their size, are supposed to have been brought by it. The true cause of blight seems to be, continued dry easterly winds for several days together, without the intervention of showers or any morning dew, by which the perspiration in the tender blossom is stopped; and if it so happen that there is a long continuance of the same weather, it equally affects the tender leaves, whereby their colour is changed and they wither and decay.

The best remedy, perhaps, is gently to wash and sprinkle over the tree, &c. from time to time, with common water; and if the young shoots seem to be much infected let them be washed with a woollen cloth, so as to clear them, if possible, from this glutinous matter, that their respiration and perspiration may not be obstructed. This operation ought to be performed early in the day, that the moisture may be exhaled before the cold of the night comes on; nor should it be done when the sun shines very hot.

Another cause of blights in the spring, is said to be sharp hoary frosts, which are often succeeded by hot sun-shine in the day-time. This is the most sudden and certain destroyer of fruit that is known. The chief remedy to be depended upon in this case is, that of protecting the fruit trees during the night-time with nets. This mode, where regularly and correctly performed, has been found highly beneficial.

What is termed the blight is frequently, however, no more than a debility or distemper in trees. Mr. Forsyth observes, that "this is the case when trees against the same wall and enjoying the same advantages in every respect, differ greatly in their health and vigour, the weak ones appearing to be continually blighted, while the others remain in a flourishing condition. This very great difference, in such circumstances, can be attributed only to the different constitutions of the trees proceeding from want of proper nourishment, or from some bad qualities in the soil; some distemper in the stock, buds, or scions; or from some mismanagement in the pruning, &c. all of which

are productive of distempers in trees, of which they are, with difficulty, cured. If the fault be in the soil it must," he says, "be dug out and fresh mould put in its place; or, the trees must be taken up, and others, better adapted to the soil, planted in their room. It will be found absolutely necessary always to endeavour to suit the particular sorts of fruit to the nature of the soil; for it is in vain to expect all sorts of fruit to be good in the same soil. If the weakness of the tree proceed from an in-bred distemper it will be adviseable to remove it at once, and after renewing the earth to plant another in its place." But if the weakness is brought on by ill management in the pruning, which is frequently the case, he would advise more attention to the method of pruning and training. Besides this, "there is another sort of blight that sometimes happens pretty late in the spring, as in April or May, which is very destructive to fruit trees in orchards and open plantations, and against which we know of no effectual remedy. This is what is called a fire-blast, which, in a few hours, hath not only destroyed the fruit and leaves, but often parts of trees; and sometimes entire trees have been killed by it." As this generally happens in close plantations where the vapours from the earth and the perspiration from the trees are pent in for want of a free circulation of air to disperse them; it points out to us the only way yet known of guarding against this enemy to fruits; namely, to make choice of a clear healthy situation for kitchen-gardens, orchards, &c. and to plant the trees at such a distance as to give free admission to the air, that it may dispel those vapours before they are formed into such volumes as to occasion these blasts." But blasts may also be occasioned by the reflection of the sun's rays from hollow clouds, which sometimes act as burning mirrors, and occasion excessive heat. See APHIS.

BLINDNESS, a total privation of sight, arising from an obstruction of the functions of the organs of sight, or from an entire deprivation of them.

This defect may arise from a variety of causes, existing either in the organ of sight, or in the circumstances necessary to produce vision. Blindness will be complete, when the light is wholly excluded; or partial, when it is admitted into the eye so imperfectly as to convey only a confused perception of visible objects. Blindness may again be distinguished into periodical or permanent, transient or perpetual, natural or accidental, &c.; but these distinctions do not serve to communicate any idea of the causes of blindness.

We find various recompenses for blindness, or substitutes for the use of the eyes, in the wonderful sagacity of many blind persons, recited by Zahnius, in his "Oculus Artificialis," and others. In some, the defect has been supplied by a most excellent gift of remembering what they had seen; in others, by a delicate nose, or the sense of smelling; in others, by an exquisite touch, or a sense of feeling, which they have had in such perfection, that, as it has been said of some, they learned to hear with their eyes; as it may be said of these, that they taught themselves to see with their hands. Some have been enabled to perform all sorts of curious and subtle works in the nicest and most dexterous manner.

Aldrovandus speaks of a sculptor who became blind at twenty years of age, and yet, ten years after, made a perfect marble statue of Cosmo II. de Medicis; and another of clay like Urban VIII.

Bartholin tells us of a blind sculptor in Denmark, who distinguished perfectly well, by mere touch, not only all kinds of wood, but all the colours; and F. Grimaldi gives an instance of the like kind; besides the blind organist, living in Paris, who is said to have done the same. The most extraordinary of all is a blind guide, who, according to the report of good writers, used to conduct the merchants through the sands and desests of Arabia.

James Bernouilli contrived a method of teaching blind persons to write.

An instance, no less extraordinary, is mentioned by Dr. Bew, in the "Transactions of the Manchester Society." It is that of a person, whose name is John Metcalf, a native of the neighbourhood of Manchester, who became blind at so early an age as to be altogether unconscious of light and its various effects. His employment in the younger period of his life was that of a waggoner, and occasionally as a guide in intricate roads during the night, or when the common tracks were covered with snow. Afterwards he became a projector and surveyor of highways in difficult and mountainous parts; and, in this capacity, with the assistance merely of a long staff, he traverses the roads, ascends precipices, explores valleys, and investigates their several extents, forms, and situations, so as to answer his purpose in the best manner. His plans are designed, and his estimates form-

red, with such ability and accuracy, that he has been employed in altering most of the roads over the Peak in Derbyshire, particularly those in the vicinity of Buxton, and in constructing a new one between Wilmslow and Congleton, so as to form a communication between the great London road, without being obliged to pass over the mountain.

Although blind persons have occasion, in a variety of respects, to deplore their infelicity, their misery is in a considerable degree alleviated by advantages peculiar to themselves. They are capable of a more fixed and steady attention to the objects of their mental contemplation, than those who are distracted by the view of a variety of external scenes. Their want of sight naturally leads them to avail themselves of their other organs of corporeal sensation, and with this view to cultivate and improve them as much as possible. Accordingly they derive relief and assistance from the quickness of their hearing, the acuteness of their smell, and the sensibility of their touch, which persons who see are apt to disregard.

Many contrivances have also been devised by the ingenious for supplying the want of sight, and for facilitating those analytical or mechanical operations, which would otherwise perplex the most vigorous mind and the most retentive memory. By means of these they have become eminent proficients in various departments of science. Indeed there are few sciences in which, with or without mechanical helps, the blind have not distinguished themselves.

The case of Professor Saunderson at Cambridge is well known. His attainments and performances in the languages, and also as a learner and teacher in the abstract mathematics, in philosophy, and in music, have been truly astonishing; and the account of them appears to be almost incredible, if it were not amply attested and confirmed by many other instances of a similar kind, both in ancient and modern times.

Cicero mentions it as a fact scarcely credible, with respect to his master in philosophy, Diodotus, that "he exercised himself in it with greater assiduity after he became blind; and which he thought next to impossible to be performed without sight; that he professed geometry, and described his diagrams so accurately to his scholars, as to enable them to draw every line in its proper direction."

Jerom relates a more remarkable instance of Didymus in Alexandria, who, "though blind from his infancy, and therefore ignorant of the letters, appeared so great a miracle to the world, as not only to learn logic, but geometry also to perfection, which seems (he adds) the most of any thing to require the help of sight."

Professor Saunderson, who was deprived of his sight by the small pox, when he was only twelve months old, seems to have acquired most of his ideas by the sense of feeling; and though he could not distinguish colours by that sense, which, after repeated trials, he said was pretending to impossibilities, yet he was able, with the greatest exactness, to discriminate the minutest difference of rough and smooth in a surface, or the least defect of polish. In a set of Roman medals, he could distinguish the genuine from the false, though they had been counterfeited in such a manner, as to deceive a connoisseur, who judged of them by the eye. His sense of feeling was so acute, that he could perceive the least variation in the state of the air; and, it is said, that in a garden where observations were made on the sun, he took notice of every cloud that interrupted the observation, almost as justly as those who could see it. He could tell when any thing was held near his face, or when he passed by a tree at no great distance, provided the air was calm, and there was little or no wind: this he did by the different pulse of air upon his face. He possessed a sensibility of hearing to such a degree, that he could distinguish even the fifth part of a note; and, by the quickness of this sense, he not only discriminated persons with whom he had once conversed so long as to fix in his memory the sound of their voice, but he could judge of the size of a room into which he was introduced, and of his distance from the wall; and if he had ever walked over a pavement in courts, piazzas, &c. which reflected a sound, and was afterwards conducted thither again, he could exactly tell in what part of the walk he was placed, merely by the note which it sounded.

Sculpture and painting are arts which, one would imagine, are of very difficult and almost impracticable attainment to blind persons; and yet instances occur, which shew that they are not excluded from the pleasing, creative, and extensive regions of fancy.

De Piles mentions a blind sculptor, who thus took the likeness of the Duke de Bracciano in a dark cellar, and made a marble

statue of King Charles I. with great justness and elegance.

However unaccountable it may appear to the abstract philosophers, yet nothing is more certain in fact, than that a blind man may, by the inspiration of the Muses, or rather by the efforts of a cultivated genius, exhibit in poetry the most natural images and animated descriptions even of visible objects, without deservedly incurring the charge of plagiarism. We need not recur to Homer and Milton for attestations to this fact; they had probably been long acquainted with the visible world before they had lost their sight, and their descriptions might be animated with all the rapture and enthusiasm which originally fired their bosoms, when the grand and delightful objects delineated by them were immediately beheld. We are furnished with instances in which a similar energy and transport of description, at least in a very considerable degree, have been exhibited by those on whose minds visible objects were never impressed, or have been entirely obliterated.

Dr. Blacklock affords a surprising instance of this kind, who, though he had lost his sight before he was six months old, not only made himself master of various languages, Greek, Latin, Italian, French; but acquired the reputation of an excellent poet, whose performances abound with appropriate images and animated descriptions.

Another instance, which deserves being recorded, is that of Dr. Henry Moyes, in our own country, who, though blind from his infancy, by the ardour and assiduity of his application, and by the energy of native genius, not only made incredible advances in mechanical operations, in music, and in the languages; but acquired an extensive acquaintance with geometry, optics, algebra, astronomy, chemistry, and all other branches of natural philosophy.

From the account of Dr. Moyes, who occasionally read lectures on philosophical chemistry at Manchester, delivered to the Manchester society by Dr. Bew, it appears, that mechanical exercises were the favourite employment of his infant years: and that at a very early age he was so well acquainted with the use of edge-tools, as to be able to construct little wind-mills, and even a loom. By the sound, and the different voices of the persons that were present, he was directed in his judgment of the dimensions of the room in which they were assembled; and in this respect he determined with such a degree of accuracy, as seldom to be mistaken. His memory was singularly retentive; so that he was capable of recognizing a person on his first speaking, though he had not been in company with him for two years. He determined with surprising exactness the stature of those with whom he conversed, by the direction of their voices; and he made tolerable conjectures concerning their dispositions, by the manner in which they conducted their conversation. His eyes, though he never recollected his having seen, were not totally insensible to intense light: but the rays refracted through a prism, when sufficiently vivid, produced distinguishable effects upon them. The red produced a disagreeable sensation, which he compared to the touch of a saw. As the colours declined in violence, the harshness lessened, until the green afforded a sensation that was highly pleasing to him, and which he described as conveying an idea similar to that which he gained by running his head over smooth polished surfaces. Such surfaces, meandering streams, and gentle declivities, were the figures by which he expressed his ideas of beauty; rugged rocks, irregular points, and boisterous elements, furnished him with expressions for terror and disgust. He excelled in the charms of conversation; was happy in his allusions to visual objects; and discoursed on the nature, composition, and beauty of colours, with pertinence and precision.

This instance, and some others which have occurred, seem to furnish a presumption, that the feeling or touch of blind persons may be so improved as to enable them to perceive that texture and disposition of coloured surfaces by which some rays of light are reflected and others absorbed, and in this manner to distinguish colours.

It redounds very much to the honour of modern times, that the public attention has been directed to the improvement of the condition of blind persons; and that institutions have been formed in different countries for providing them with suitable employment, tending not only to alleviate their calamity, but to render them useful. The first regular and systematic plan for this purpose was proposed by M. Hally in an "Essay on the Education of the Blind," printed at Paris in the year 1786, under the patronage of the Academy of Sciences. An English translation of this essay is annexed to "Dr. Blacklock's Poems," printed at Edinburgh in 1793, 4to. The object of

this plan is to teach the blind reading, by the assistance of books, in which the letters are rendered palpable by their elevation above the surface of the paper; and by these means to instruct them, not only in the liberal arts and sciences, but likewise in the principles of mechanical operations, such as spinning, knitting, book-binding, &c. so that those who are in easy circumstances may be capable of amusing employment, and those of the lower ranks of life, and such as have no genius for literary improvement, may nevertheless become respectable, useful, and independent members of society, in the situation of common artisans. By these palpable characters, they are taught to read, to write, and to print; and they are likewise instructed, according to their several talents and stations, in geometry, algebra, geography, and every branch of natural philosophy. The institution encourages and cherishes a taste for the fine arts; it teaches the blind to read music with their fingers, as others do with their eyes; and it does this with so much success, that though they cannot at once feel the notes and perform them upon an instrument, yet they are capable of acquiring any lesson with as much exactness and rapidity, as those who enjoy all the advantages of sight.

We are happy to add, that institutions of a similar kind have been established in our own country; and to render our particular tribute of respect to the founders and supporters of the school for the indigent blind, instituted in London, 1799. The object, with a view to which this school was founded, is unquestionably one of the most important and interesting kind that can excite compassion, or demand encouragement. It provides instruction for the indigent blind, in a trade by which they may be able to provide, either wholly or in part, for their own subsistence; and thus, instead of being altogether a burden to the community, they will be of some service to it; and instead of being depressed and cheerless themselves, under a sense of their total dependence, and for want of regular employment, habits of industry will relieve their spirits, and produce the most beneficial effects on their state and character. The children of this institution are completely clothed, boarded, lodged, and instructed, gratis. The articles at present manufactured in the school are shoemakers'-thread, fine and coarse thread, window sash-line, and clothes-line (of a peculiar construction, and made on a machine adapted to the use of blind persons) by the females; and window and sash-line, clothes-line, hampers, and wicker-baskets, by the males.

The success that has crowned the efforts of the friends of this institution, since its first establishment, affords sufficient evidence of the degree in which the situation and faculties of the blind are capable of improvement; and a view of it in its present prosperous state must be gratifying to persons of humane and compassionate feelings. Here they will not find the scholars sitting in listless indolence, which is commonly the case with the blind, or brooding in silence over their own defects, and their inferiority to the rest of mankind; but they will behold a number of individuals, of a class hitherto considered as doomed to a life of sorrow and discontent, and to be provided for merely in alms-houses, or by donations of charity, not less animated in their amusements, during the hours of recreation, and far more cheerfully attentive to their work in those of employment, than persons possessed of sight.

To this article we shall subjoin the following directions given by Mr. Thicknesse, for teaching the blind to write. "Let any common joiner make a flat board, about 14 inches long and 12 wide, in the middle of which let a place be sunk, deep enough, when lined with cloth, to hold only two or three sheets of fool's-cap paper, which must quite fill up the space: over this must be fixed a very thin false frame, which is to cover all but the paper, and fastened on by four little pins, fixed in the lower board, and across the lower frame, just over the paper, must be a little slider, an inch and a half broad, to slip down into several recesses made in the upper frame, at a proper distance for the lines, which should be near an inch asunder; and this ruler, on which the writer is to rest his fourth and little finger, must be made full of little notches, at a quarter of an inch distant from each other; and these notches will inform the writer, by his little finger dropping from notch to notch, how to avoid running one letter into another. When he comes to the end of the line, he must move his slider down to the next groove, which may easily be so contrived with a spring to give warning that it is properly removed to the second line, and so on."

BLINDS, or BLINDES, in the art of war, a sort of defence commonly made of oziers, or branches interwoven, and laid across between two rows of stakes, about the height

of a man, and four or five feet asunder, used particularly at the heads of trenches, when they are extended in front towards the glacis; serving to shelter the workmen, and prevent their being overlooked by the enemy.

BLINK, of the ice, in sea language, that dazzling whiteness about the horizon which is occasioned by the reflection of light from the fields of ice.

BLISTER, in medicine, a thin bladder containing a watery humour, whether occasioned by burns and the like accidents, or by vesicatories laid on different parts of the body for that purpose.

BLITUM, in botany, a genus of the Monandria Digynia class and order. Natural order of Holoraceæ; Atriplices, Jussieu. Essential character: calyx trifid; petal none; seed one, with a berried calyx. There are four species, of which B. capitatum is an annual plant with leaves somewhat like those of spinach; the stalk rises about two feet and a half high in gardens; the upper part of it has flowers coming out in small heads at every joint, and is terminated by a small cluster of the same. After the flowers are past, these little heads swell to the size of wood strawberries, and when ripe have the same appearance, being very succulent and full of a purple juice, which stains the hands. It is commonly called strawberry blite, strawberry spinach, or bloody spinach; by some, berry-bearing orach. Native of Switzerland, the Grisons, Austria, the Tyrol, Spain, and Portugal.

B. virgatum seldom grows more than one foot high, with smaller leaves than the capitatum, but of the same shape. The flowers are small, and collected into little heads, shaped like those of the first, but smaller, and not so deeply coloured. A native of the South of France, Spain, Italy, and Tartary. Of the other species, the one rises more than three feet high: the other is a very low plant, and is found in Tartary and Sweden.

BLOCKS, on ship-board, is the usual name for what we call pullies at land. They are thick pieces of wood, some with three, four, or five shivers in them, through which all the running ropes run. Blocks, whether single or double, are distinguished and called by the names of the ropes they carry, and the uses they serve for.

Double blocks are used when there is occasion for much strength, because they will purchase with more ease than single blocks, though much slower.

Block and block, is a phrase signifying that two blocks meet, in haling any tackle or halliard, having such blocks belonging to them.

The blocks now used in the navy are made in Portsmouth by means of circular saws and other machinery, which have been lately erected by a most ingenious mechanician. This machinery performs the several operations from the rough timber to the perfect block, in the completest manner possible. The whole is worked by means of a steam engine; the manual labour required is simply to supply the wood as it is wanted to the several parts of the machinery, so that the commonest labourer almost may be made to act in this business with very little instruction.

Fish block is hung in a notch at the end of the davit; it serves to hale up the flooks of the anchor at the ship's brow.

Snatch block is a great block with a shiver in it, and a notch cut through one of its cheeks for the more ready receiving of any rope; as by this notch the middle part of a rope may be reeved into the block without passing it endwise. It is commonly fastened with a strap about the main-mast, close to the upper deck, and is chiefly used for the fall of the winding tackle, which is reeved into this block, and then brought to the capstan.

Block *house*, a kind of wooden fort or battery, either mounted on rollers or on a vessel, and serving either on the water or in counterscarps and counter approaches. The name is sometimes also given to a brick or stone fort built on a bridge, or the brink of a river, serving not only for its defence but for the command of the river both above and below: such was that noted block-house anciently on the bridge of Dresden, since demolished on enlarging the bridge.

BLOCKADE, in the art of war, the blocking up a place by posting troops at all the avenues leading to it, to keep supplies of men and provisions from getting into it; and by these means proposing to starve it out without making any regular attacks.

To raise a blockade is to force the troops that keep the place blocked up from their posts.

BLOOD is a well-known fluid, which circulates in the veins and arteries of the more perfect animals. It is of a red colour, has a considerable degree of consistency, and an unctuous feel, as if it contained a quantity of soap. Its taste is slightly saline, and it has a peculiar smell.

The specific gravity of human blood is, at a medium, 1.05. Mr. Fourcroy found the specific gravity of bullock's blood, at the temperature of 60°, to be 1.056. The blood does not uniformly retain the same consistence in the same animal, and its consistence in different animals is very various. It is easy to see that its specific gravity must be equally various. When blood, after being drawn from an animal, is allowed to remain for some time at rest, it very soon coagulates into a solid mass, of the consistence of curdled milk. This mass gradually separates into two parts, one of which is fluid, and is called serum; the other, the coagulum, has been called cruor, because it alone retains the red colour which distinguishes blood. This separation is very similar to the separation of curdled milk into curds and whey. The proportion between the cruor and serum of the blood varies much in different animals, and even in the same animal in different circumstances. The most common proportion is about one part of cruor to three parts of serum. 1. The serum is of a light greenish yellow colour: it has the taste, smell, and feel of the blood, but its consistence is not so great. It converts syrup of violets to a green, and therefore contains an alkali. On examination, Roulle found that it owes this property to a portion of soda. When heated to the temperature of 156°, the serum coagulates. It coagulates also when boiling water is mixed with it, but if serum be mixed with six parts of cold water, it does not coagulate by heat. When coagulated, it has a greyish white colour, and is not unlike the boiled white of an egg. If the coagulum be cut into small pieces, a muddy fluid may be squeezed from it, which has been termed the serosity. After the separation of this fluid, if the residuum be carefully washed in boiling water and examined, it will be found to possess all the properties of coagulated albumen. The serum, therefore, contains a considerable proportion of albumen. Hence its coagulation by heat, and the other pheonomena which albumen usually exhibits. If serum be diluted with six times its weight of water, and then boiled to coagulate the albumen, the liquid which remains after the separation of the coagulum, if it be gently evaporated till it becomes concentrated, and then be allowed to cool, assumes the form of a jelly. Consequently it contains gelatine. If the coagulated serum be heated in a silver vessel, the surface of the silver becomes black, being converted into a sulphuret. Hence it is evident, that it contains sulphur; and Proust has ascertained that it is combined with ammonia in the state of a hydrosulphuret. If serum be mixed with twice its weight of water, and, after coagulation by heat, the albumen be separated by filtration, and the liquid be slowly evaporated till it is considerably concentrated, a number of crystals are deposited when the liquid is left standing in a cool place. These crystals consist of carbonate of soda, muriate of soda, besides phosphate of soda and phosphate of lime. The soda exists in the blood in a caustic state, and seems to be combined with the gelatine and albumen. The carbonic acid combines with it during evaporation. Thus it appears that the serum of the blood contains albumen, gelatine, hydrosulphuret of ammonia, soda, muriate of soda, phosphate of soda, and phosphate of lime. These component parts account for the coagulation occasioned in the serum by acids and alcohol, and the precipitation produced by tannin, acetate of lead, and other metallic salts. The cruor, or clot, as it is sometimes called, is of a red colour, and possesses considerable consistence. Its mean specific gravity is about 1.245. If this cruor be washed carefully, by letting a small jet of water fall upon it, till the water runs off colourless, it is partly dissolved, and partly remains upon the searce. Thus it is separated into two portions: namely, 1. A white, solid elastic substance, which has all the properties of fibrin; 2. The portion held in solution by the water, which consists of the colouring matter, not, however, in a state of purity, for it is impossible to separate the cruor completely from the serum. We are indebted to Bucquet for the first precise set of experiments on this last watery solution. It is of a red colour. Bucquet proved that it contained albumen and iron. Menghini had ascertained, that if blood be evaporated to dryness by a gentle heat, a quantity of iron may be separated from it by the magnet. The quantity which he obtained was considerable; according to him, the blood of a healthy man contains above two ounces of it. Now, as neither the serum nor the fibrin extracted from the cruor contains iron, it follows of course, that the water holding the colouring matter in solution must contain the whole of that metal. This watery solution gives a green colour to syrup of violets. When exposed to the air, it gradually deposits flakes, which have the

properties of albumen. When heated, a brown-coloured scum gathers on its surface. If it be evaporated to dryness, and then mixed with alcohol, a portion is dissolved, and the alcoholic solution yields by evaporation a residuum, which lathers like soap in water, and tinges vegetable blues green; the acids occasion a precipitate from its solution. This substance is a compound of albumen and soda. Thus we see that the watery solution contains albumen, iron, and soda. When new-drawn blood is stirred briskly round with a stick or the hand, the whole of the fibrin collects together upon the stick, and in this manner may be separated altogether from the rest of the blood. The red globules in this case remain behind in the serum. It is in this manner that the blood is prepared for the different purposes to which it is put; as clarifying sugar, making puddings, &c. After the fibrin is thus separated, the blood no longer coagulates when allowed to remain at rest, but a spongy flaky matter separates from it, and swims on the surface.

BLUE, otherwise called azure, is one of the primitive colours of the rays of light.

BLUE, *painters*, is made different according to the different kinds of painting.

In limning, fresco, and miniature, they use indifferently ultramarine, blue ashes, and smalt: these are their natural blues, excepting the last, which is partly natural and partly artificial.

In oil and miniature they also use indigo prepared; as also a fictitious ultramarine.

Enamellers and painters upon glass have blues proper to themselves, each preparing them after their own manner.

BLUING *of iron*, a method of beautifying that metal sometimes practised; as for mourning buckles, swords, or the like. The manner is thus; take a piece of grindstone and whetstone, and rub hard on the work to take off the black scurf from it; then heat it in the fire, and as it grows hot the colour changes by degrees, coming first to a light, then to a dark gold colour, and lastly to a blue. Sometimes they grind also indigo and sallad oil together, and rub the mixture on the work with a woollen rag while it is heating, leaving it to cool of itself. Among sculptors we also find mention of bluing a figure of bronze, by which is meant the heating of it to prepare it for the application of gold leaf, because of the bluish cast it acquires in the operation.

BLUENESS, that quality which denominates a body blue, depending on such a size and texture of the parts that compose the surface of a body, as dispose them to reflect the blue or azure rays of light, and those only, to the eye.

With respect to the blueness of the sky, M. de la Hire, after Leonardo da Vinci, observes, that any black body, viewed through a thin white one, gives the sensation of blue; and this he assigns as the reason of the blueness of the sky, the immense depth of which, being wholly devoid of light, is viewed through the air illuminated and whitened by the sun. For the same reason, he adds, it is, that soot mixed with white makes a blue; for white bodies, being always a little transparent, and mixing themselves with a black behind, give the perception of blue. From the same principle he accounts for the blueness of the veins on the surface of the skin, though the blood they are filled with be a deep red; for red, he observes, unless viewed in a clear, strong light, appears a dark brown, bordering on black; being then in a kind of obscurity in the veins, it must have the effect of a black; and this, viewed through the membrane of the vein and the white skin, will produce the perception of blueness.

In the same way did many of the early writers account for the phenomenon of a blue sky; but, in the explanation of this phenomenon, Sir Isaac Newton observes, that all the vapours, when they begin to condense and coalesce into natural particles, become first of such a bigness as to reflect the azure rays, before they can constitute clouds of any other colour. This, therefore, being the first colour which they begin to reflect, must be that of the finest and most transparent skies, in which the vapours are not arrived to a grossness sufficient to reflect other colours.

M. Bouguer, without having recourse to the vapours diffused through the atmosphere, in order to account for the reflection of the blue-making rays, ascribes it to the constitution of the air itself, whereby these fainter-coloured rays are incapable of making their way through any considerable tract of it: and he accounts for those blue shadows, which were first observed by M. Buffon in the year 1742, by the aërial colour of the atmosphere, which enlightens these shadows, and in which the blue rays prevail; whilst the red rays are not reflected so soon, but pass on to the remoter regions of the atmosphere.

The Abbé Mazeas, in a Memoir of the Society in Berlin, for the year 1752, ac-

counts for the phenomenon of blue shadows, by the diminution of light; having observed, that of two shadows which were cast upon a white wall, from an opaque body illuminated by the moon, and by a candle at the same time, that which was enlightened by the candle was reddish, and that which was enlightened by the moon was blue. However, the true cause of this appearance seems to be that assigned by M. Bouguer, which agrees with the solution given of it about the same time by Mr. Melville. But, instead of attributing the different colours of the clouds, as Sir Isaac Newton does, to the different size of those globules into which the vapours are condensed; Mr. Melville supposes, that the clouds only reflect and transmit the sun's light; and that, according to their different altitudes, they may assume all the variety of colours at sun-rising and setting, by barely reflecting the sun's incident light, as they receive it through a shorter or longer tract of air: and the change produced in the sun's rays by the quantity of air through which they pass, from white to yellow, from yellow to orange, and lastly to red, may be understood agreeably to this hypothesis, by applying to the atmosphere what Sir Isaac Newton says concerning the colour of transparent liquors in general, and that of the infusion of lignum nephriticum in particular.

BLUSHING, a suffusion or redness of the cheeks, excited by a sense of shame on account of a consciousness of some failing or imperfection.

Blushing is supposed to be produced from a kind of consent or sympathy between the several parts of the body, occasioned by the same nerve being extended to them all. Thus the fifth pair of nerves being branched from the brain to the eye, ear, muscles of the lips, cheeks and palate, tongue and nose; a thing seen or heard that is shameful affects the cheeks with blushes, driving the blood into their minute vessels at the same time that it affects the eye and ear. Mr. Derham further observes, upon this subject, that a savory thing seen or smelt affects the glands and parts of the mouth; if a thing heard be pleasing, it affects the muscles of the face with laughter; if melancholy, it exerts itself on the glands of the eyes, and occasions weeping, &c. To the same cause is, by others, the pleasure of kissing ascribed.

B MI, in music, the third note in the modern scale.

B MOLLARRE, or MOLLE, one of the notes of the scale of music, usually called soft or flat, in opposition to b quadro.

BOA, in natural history, a genus of serpents, of which the generic character is, plates on the belly and under the tail, with a rattle. Gmelin mentions ten species only, but Dr. Shaw and others enumerate as many as eighteen. B. contortrix is found in Carolina, and has about 150 plates on the belly, and 40 on the tail; it is broad with a convex back; colour cinereous, with lateral round spots; has a poisonous bag, but no fangs; tail from one third to a half the length of the whole body: it is very slow in its motions. B. constrictor, is very remarkable for its vast size, some of the principal species which are met with in India, Africa, and South America, have been seen between 30 and 40 feet long, and possessed of so much strength as to be able to kill cattle by twisting around them and crushing them to death by pressure, after which they devour them, eating till they are almost unable to move; in that state they may be easily shot. Dr. Shaw observes that these gigantic serpents are become less common, in proportion to the increased population of the parts where they are found; they are, however, still to be seen, and will approach the abodes in the vicinity of their residence. This species is beautifully variegated with rhombic spots; belly whitish; is of vast strength and size, measuring 30 and 36 feet long. With respect to age, sex, and climate, it is subject to considerable variations. It is supposed that an individual of this species once diffused terror and dismay in a whole Roman army, a fact alluded to by Livy in one of the books that have not come to us, but which is quoted by Valerius Maximus, in words to the following effect: "Since we are on the subject of uncommon phenomena, we may here mention the serpent so eloquently recorded by Livy, who says, that near the river Bagrada in Africa, a snake was seen of so enormous a magnitude as to prevent the army of Attilius Regulus from the use of the river; and after snatching up several soldiers with its enormous mouth and devouring them, and killing several more by striking and squeezing them with the spires of its tail, was at length destroyed by assailing it with all the force of military engines and showers of stones, after it had withstood the attack of their spears and darts: that it was regarded by the whole army as a more formidable enemy than even Carthage itself; and that the

whole adjacent region being tainted with the pestilential effluvia proceeding from its remains, and the waters with its blood: the Roman army was obliged to remove its station. The skin of the monster was 120 feet long, and was sent to Rome as a trophy."

Another account says, that "it caused so much trouble to Regulus that he found it necessary to contest the possession of the river with it, by employing the whole force of the army, during which a considerable number of soldiers were lost, while the serpent could neither be vanquished nor wounded: the strong armour of its scales easily repelling the force of all the weapons that were directed against it; upon which recourse was had to battering engines, with which the animal was attacked in the manner of a fortified tower, and was thus at length overpowered. Several discharges were made against it without success, till its back being broken by an immense stone, the monster began to lose its powers, and was with difficulty destroyed; after having diffused such a horror among the army that they confessed they would rather attack Carthage itself than such another monster.'

The flesh of the serpent is eaten by the Indians and Negroes of Africa, and they make its skin into garments.

Boa *scytale*, or *spotted*. The spotted boa is sometimes scarcely inferior in size to the constrictor, and is of similar manners, destroying, like that animal, goats, sheep, deer, &c. It is described as being generally of a grey or glaucous colour, marked with large orbicular black spots on the back; and with smaller ones of similar form, but with white centres on the sides; while on the abdomen are scattered several oblong spots and marks, interspersed with smaller specks and variegations. It is a native of several parts of South America, and like other large snakes is occasionally eaten by the Indians.

Boa *canina*, a highly beautiful snake, measuring about four feet in length, and being of moderate size or thickness in proportion: the head is large, and shaped like that of a dog; the colour of the whole animal on the upper parts is a most beautiful Saxon-green, with several short, undulating, transverse white bars down the back, the edges of which are of a deeper or stronger green than the ground colour of the body: the under or abdominal part is white. This species is a native of South America. In the British Museum is an elegant specimen. See Plate Serpentes, fig. 3.

Boa *phrygia*. Among the whole serpent tribe it may be doubted whether there exists a species more truly elegant than the present. Its general size seems to be nearly that of the boa canina, but its length is rather greater in proportion: the ground colour of the whole animal is white, with a very slight cast of yellowish brown on the back, while along the whole upper part is disposed a continued series of black variegations, so conducted as to bear a striking resemblance to an embroidery in needlework: the head is of the same form with that of the boa canina, and marked by three narrow black streaks, which, running along the top of the head and the cheeks, join with the embroidered pattern of the back.

Boa *hortulana* is of moderate size, measuring only a few feet in length, and being of a slender form; has obtained its Linnæan title from the singular variegations on the head, which are of a blackish brown, on a pale ferruginous or yellowish ground, and in some degree represent the form of a parterre in an old-fashioned garden: the variegations on the body are of similar colour, and are disposed into large circular, and sometimes angular patches on the sides.

Boa *fasciata*. It is to Dr. Patrick Russel that we owe the knowledge of this remarkable species, which is a native of India, and is said to be most frequent in the country of Bengal. It is of a yellow colour, marked with pretty numerous dusky-blue transverse bands, continued at equal distances: the head is rather small, and covered in front with large scales: the body is of a trigonal form, the sides sloping very considerably: the whole length of the animal is something more than five feet; the diameter, in the thickest part being nearly five inches: the length of the tail five inches only, and its termination rather obtuse. This snake is among the number of poisonous species, and its bite is considered by the Indians as inevitably fatal. A specimen was brought to Dr. Russel in the month of November, 1788, in an apparently weak and languid state, having been bruised in taking. Being set at liberty in a room, it crept slowly towards an obscure corner, where a chicken being presented to him, he took no particular notice of it, and even suffered the bird to stand on his back. As he shewed no disposition to bite, his jaws were forcibly opened, and the thigh of the chicken being placed between them, the mouth was so

closed over it as to oblige the fangs to act. The bird, when disengaged, shewed immediately symptoms of poison; and after several ineffectual efforts to rise, rested with the beak on the ground, the head being seized with trembling. In the space of 20 minutes it lay down on one side, and convulsions soon supervening, it expired within 26 minutes from the bite.

BOAR. See Sus.

BOARD, among seamen. To go abroad, signifies to go into the ship. To slip by the board, is to slip down by the ship's side. Board and board, is when two ships come so near as to touch one another, or when they lie side by side. To make a board is to turn to windward; and the longer your boards are, the more you work into the wind. To board it up, is to beat it up sometimes upon one tack, and sometimes upon another. She makes a good board, that is, the ship advances much at one tack. The weather board, is that side of the ship which is to windward.

BOARDING a ship, is entering an enemy's ship in a fight. In boarding a ship, it is best to bear up directly with him, and to cause all your ports to leeward to be beat open; then bring as many guns from your weather side, as you have ports for; and laying the enemy's ship on board, loof for loof, order your tops and yards to be manned, and furnished with necessaries; and let all your small shot be in readiness; then charge at once, with both small and great, and at the same time, enter your men under cover of the smoke, either on the bow of your enemy's ship, or bring your midship close up with her quarter, and so enter your men by the shrouds: or if you would use your ordnance, it is best to board your enemy's ship athwart her hawse; for, in that case, you may use most of your great guns, and she only those of her prow. Let some of your men endeavour to cut down the enemy's yards and tackle, whilst others clear the decks, and beat the enemy from aloft. Then let the scuttles and hatches be broke open with all possible speed to avoid trains, and the danger of being blown up by barrels of powder placed under the decks.

Another method is described in Falconer's Marine Dictionary, which is as follows: the assailant having previously selected his men armed with pistols and cutlasses, A number of powder flasks, fitted with a fuzes, are provided, to be thrown upon the enemy's deck immediately before the assault. Besides this, the boarder is generally furnished with an earthen shell, called a stink-pot, which, on that occasion, is suspended from his yard-arms or bowsprit end. This machine is also charged with powder, mixed with other inflammable and suffocating materials, with a lighted fuze at the aperture. Thus prepared, and having grappled his adversary, the boarder displays his signal to begin the assault. The fuzes of the stink-pot and powder-flasks being lighted, they are immediately thrown upon the deck of the enemy, where they burst and catch fire, producing an intolerable stench and smoke, and filling the deck with tumult and distraction. Amidst the confusion occasioned by this infernal apparatus, the detachment provided, rush aboard, sword in hand, under cover of the smoke, on their antagonist, who is in the same predicament with a citadel stormed by besiegers, and generally overpowered, unless he is furnished with extraordinary means of defence, or equipped with places of retreat, furnished with small arms, &c. which may be fired at any time upon the boarders, and frequently with success.

BOAT, is a small open vessel worked by oars or sails. The construction and names of boats are different, according to the purposes for which they are intended. The boats or wherries plying on the Thames about London are either scullers, wrought by a single person with oars; or oars, wrought by two persons each with an oar.

Boat, *life*, a boat invented by Mr. Henry Greathead, of South Shields, for the purpose of preserving the lives of shipwrecked persons.

In the year 1802, the Society of Arts rewarded the inventor with their gold medal and fifty guineas for his invention. The length of the boat is 30 feet, and both ends are made exactly similar, so that she may be rowed in either direction; and she is steered by an oar at each end, in the place of a rudder. These oars are one third longer than the rowing oars, and afford a great power to set the boat straight to meet the waves in a proper manner; she is generally rowed by ten oars, and will carry a great number af passengers, though she should be full of water. This is owing to a considerable quantity of cork made fast to her gunwale, which at the same time renders her very buoyant, and guards her against being stowed by running foul of a ship's side, &c. The particular construction of this boat will be best understood

by referring to Plate LIFE BOAT, &c. in which

Fig. 1. *A cross section of the Life Boat.*

F, F. The outside coatings of cork.

G G. The inside cork filling.

H, H. The outside planks of the boat.

I. One of the stems of the boat.

K. The keel.

N, N. The timber-heads.

P. The thwarts, or rowers' seats.

R. One of the stanchions under the thwarts, each being thus firmly supported.

S. A section of the gang-board, which crosses the thwarts, and forms the passage from one end of the boat to the other.

T. The floor-heads, or platform for the rowers' feet.

V, V. The two bilge pieces, nearly level with the keel.

W, W. The gunwales.

X. A ring bolt for the head-fast, there being another also at the other end.

Y. Platform for the steersman.

Fig. 2. *A longitudinal section of the Life Boat.*

E E E. The sheer or curve of the boat.

I, I. The two sterns or ends.

K. The keel.

L, L. The aprons, to strengthen the stems.

M, M. The sheets, or place for passengers.

N, N. Timber heads, or boat-fastenings.

O, O, O, O. The tholes on which the oars are slung by gromets.

T. Flooring under the rowers' feet.

Fig. 3. *Plan of a Truck or Carriage with four wheels, to convey the boat to and from the sea.*

a. An oblong frame of wood consisting of two long pieces, hollowed a little to admit the body of the boat, and secured by the cross pieces *b, b.*

c, c, c, c. Four low wheels, each sunk or hollowed in the middle to run better upon a rail-way or timber-road.

d, d. Two indents made in the side timbers, that the bottom of the boat may be firm therein.

e, e. Two small rollers moveable in the cross timbers for the keel of the boat to slide upon.

f, f. Two long rollers, one at each end of the frame, to assist in raising the boat upon, or sliding it off the truck or carriage.

This boat went off on the 30th of January, 1790; and so well has it answered, and even exceeded, every expectation, in the most tremendous sea, that during the last eighteen years, not fewer than between two and three hundred lives have been saved at the entrance of the Tyne alone, which otherwise must have been lost; and in no instance has it ever failed. This useful, and, to a maritime nation, highly important invention, was occasioned by the following circumstance: In September, 1789, the ship Adventure, of Newcastle, was stranded on the south-side of Tynemouth Haven, in the midst of the most tremendous breakers, and all the crew dropped from the rigging one by one, in the presence of thousands of spectators; not one of whom could be prevailed upon by any reward to venture out to her assistance, in any boat of the common construction. On this melancholy occasion the gentlemen of South Shields called a meeting of the inhabitants, and premiums were instantly offered for plans of a boat which should be the best calculated to brave the dangers of the sea, particularly of broken water. Many persons laid claim to the reward, but the preference was given unanimously to Mr. Greathead's.

The principle of this boat appears to have been suggested to the inventor by the following simple fact:—Take a spheroid, and divide it into quarters; each quarter is elliptical, and nearly resembles the half of a wooden bowl, having a curvature with projecting ends; this, thrown into the sea or broken water, cannot be upset, or lie with the bottom upwards. The length of the boat is, as we have seen, thirty feet; the breadth ten feet; the depth, from the top of the gunwale to the lower part of the keel in midships, three feet three inches; from the gunwale to the platform (within), two feet four inches; from the top of the stems (both ends being similar) to the horizontal line of the bottom of the keel, five feet nine inches. The keel is a plank of three inches thick, of a proportionate breadth in midships, narrowing gradually towards the ends, to the breadth of the stems at the bottom, and forming a great convexity downwards. The ends of the bottom section form that fine kind of entrance observable in the lower part of the bow of the fishing-boat, called a coble, much used in the north. From this part to the top of the stem it is more elliptical, forming a considerable projec-

LIFE BOAT &c.

Sections of Mr. Greathead's Life Boat
and a plan of the Carriage for moving the Boat on Land.

Fig. 1.

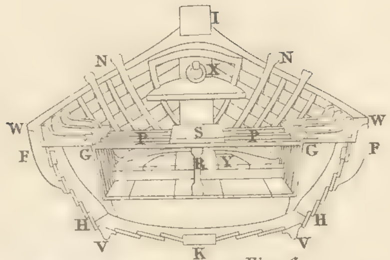


Fig. 2.

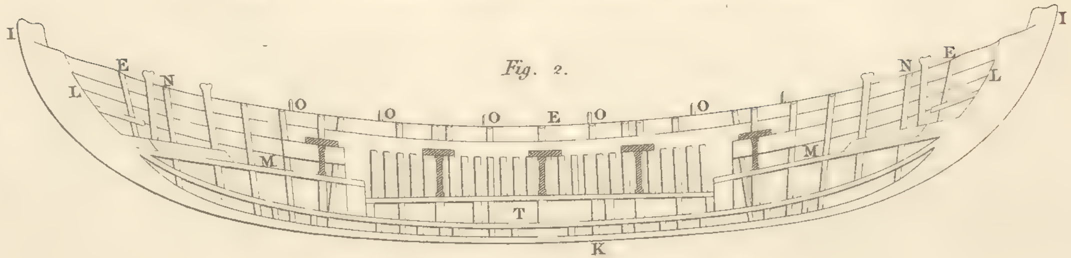


Fig. 3.

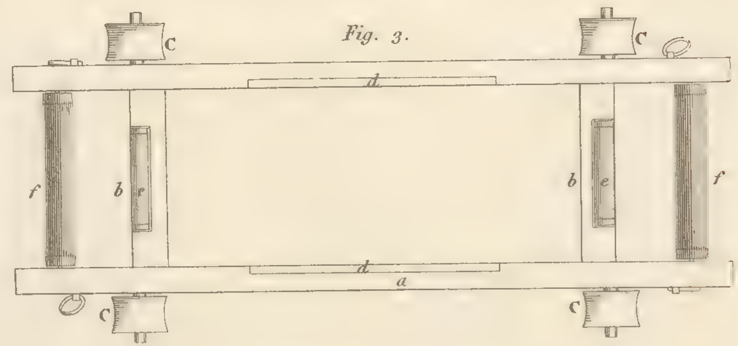


Fig. 4. Fig. 5.

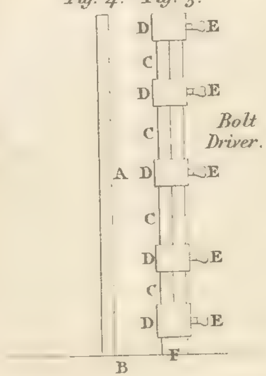


Fig. 6.

Fig. 7.

J. Farey Junr. delin.

Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, March 1.1808.

tion. The sides, from the floor-heads to the top of the gunwale, flaunch off on each side, in proportion to above half the breadth of the floor. The breadth is continued far forwards towards the ends, leaving a sufficient length of straight side at the top. The sheer is regular along the straight side, and more elevated towards the ends. The gunwale fixed to the outside is three inches thick. The sides, from the under part of the gunwale, along the whole length of the regular sheer, extending twenty-one feet six inches, are cased with layers of cork, to the depth of sixteen inches downwards; and the thickness of this casing of cork being four inches, it projects at the top a little without the gunwale. The cork on the outside is secured with thin plates, or slips of copper, and the boat is fastened with copper nails. The thwarts, or seats, are five in number, double banked; consequently the boat may be rowed with ten oars. The boat is steered with an oar at each end; and the steering oar is one third longer than the rowing oar. The platform placed at the bottom, within the boat, is horizontal, the length of the midships, and elevated at the ends, for the convenience of the steersman, to give him a greater power with the oar. The internal part of the boat next the sides is cased with cork; the whole quantity of which affixed to the life-boat is nearly seven hundred weight. The cork, indisputably, contributes much to the buoyancy of the boat, is a good defence in going along-side a vessel, and is of principal use in keeping the boat in an erect position in the sea; or, rather, for giving her a very lively and quick disposition to recover from any sudden cant or lurch, which she may receive from the stroke of a heavy wave. But, exclusively of the cork, the admirable construction of this boat gives it a decided pre-eminence. The ends being similar, the boat can be rowed either way; and this peculiarity of form alleviates her in rising over the waves. The curvature of the keel and bottom facilitates her movement in turning, and contributes to the ease of the steerage, as a single stroke of the steering oar has an immediate effect, the boat moving as it were upon a centre. The fine entrance below is of use in dividing the waves, when rowing against them; and, combined with the convexity of the bottom, and the elliptical form of the stem, admits her to rise with wonderful buoyancy in a high sea, and to launch forward with rapidity, without shipping any water, when a common boat would be in danger of being filled. The internal shallowness of the boat from the gunwale down to the platform, the convexity of the form, and the bulk of cork within, leave a very diminished space for the water to occupy; so that the life boat, when filled with water, contains a considerable less quantity than the common boat, and is in no danger either of sinking or overturning.

It may be presumed by some, that in cases of high wind, agitated sea, and broken waves, a boat of such a bulk could not prevail against them by the force of oars; but the life-boat, from her peculiar form, may be rowed a-head, when the attempt in other boats would fail. Boats of the common form, adapted for speed, are, of course, put in motion with a small power; but, for want of buoyancy and bearing, are over-run by the waves, and sunk, when impelled against them; and boats constructed for burthen meet with too much resistance from the wind and sea, when opposed to them, and cannot, in such cases, be rowed from the shore to a ship in distress.

BOATSWAIN, a ship-officer, to whom is committed the charge of all the tacklings, sails, and rigging, ropes, cables, anchors, flags, pendants, &c. He is also to take care of the long-boat and its furnitnre, and to steer her either by himself or his mate.

He calls out the several gangs and companies aboard, to the due execution of their watches, works, spells, &c. He is likewise provost-marshal, who sees and punishes all offenders sentenced by the captain, or a court-martial of the fleet. He ought frequently to examine the condition of the masts, sails, and rigging, and remove whatever may be unfit for service, or supply what is deficient; and he is ordered by his instructions to perform his duty "with as little noise as possible."

Boatswain's *mate* has the peculiar command of the long boat, for the setting forth of anchors, weighing or fetching home an anchor, warping, towing, or mooring; and is to give an account of his store.

BOB, a term used for the ball of a short pendulum.

Bob, in ringing of bells, denotes a peal consisting of several courses, or sets of changes.

BOBARTIA, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is imbricated, and contains only a single flower; the corolla is a glume, con-

sisting of two valves, and placed on the germen; the seed is single, of an oval figure, and is contained in the cup.

BOBBIN, a small piece of wood turned in the form of a cylinder, with a little border jutting out at each end, bored through to receive a small iron pivot. It serves to spin with the spinning-wheel, or to wind thread, worsted, hair, cotton, silk, gold, and silver.

BOBBING, among fishermen, a particular manner of catching eels different from sniggling.

BOB-STAYS, in nautical language, ropes used to confine the bowsprit downward to the stem or cut-water. A bob-stay is fixed by thrusting one of its ends through a hole bored in the fore part of the cut-water for this purpose, then splicing both ends together, so as to make it two-fold, or like the link of a chain; a dead-eye is then seized into it, and a laniard passing through this and communicating with another dead-eye upon the bowsprit is drawn extremely tight by the help of mechanical powers. The use of the bob-stay is to draw down the bowsprit, and keep it steady, and to counteract the force of the stays of the foremast which draws it upwards. The bowsprit is also fortified by shrouds from the bows on each side: on this and other accounts the bob-stay is the first part of a ship's rigging which is drawn tight to support the masts.

BOCARDO, among logicians, the fifth mode of the third figure of syllogisms, in which the middle proposition is an universal affirmative, and the first and last particular negatives, thus:

Bo Some sickly persons are not students;
CAR Every sickly person is pale;
DO Therefore some persons are pale that are not students.

BOCCONIA, in botany, so called from a Sicilian monk, a genus of the Dodocandria Monogynia class and order. Natural order of Rhoeadeæ: Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla none; style bifid; berry dry, one-seeded. There is only one species, *viz.* B. frutescens, shrubby bocconia, tree celandine, or parrot weed, is a shrub rising to the height of ten or twelve feet; with a straight trunk as large us a man's arm, covered with a white smooth bark, and branched towards the top. The trunk is hollow, filled with a pith, like the alder, abounding in a thick yellow juice, like argemone and celandine; branches brittle, unequal, marked with scars from the fallen leaves; leaves from six or seven inches to a foot in length; filaments ten, seldom more, longer than the leaflets of the calyx, hanging down loose; anthers longer than the filaments. It is a native of the West India islands, where the juice of it is used to take off tetters and warts.

BOCK-LAND, in the Saxons' time, is what we now call freehold lands, held by the better sort of persons by charter or deed in writing, by which name it was distinguished from folkland, or copyhold land, holden by the common people without writing.

BODIANUS, in natural history, a genus of fishes of the order Thoracici, of which the generic character is, habit of the genus Perca, gill-covers scaly, serrated, and aculeated; scales generally smooth. They are divided into two classes, one with divided or forked tails: the other with even or rounded tail. Dr. Shaw, in his excellent zoology, enumerates fifteen species. The B. luteus, is about fourteen inches long, and in shape like a trout; the colour is yellow, each scale being deeply edged or tipped with orange; the back is purplish rose-colour with scales tipped with blue; tail nearly in the middle, but running into a lanceolate tip at each side. It is a native of the South America seas. B. pentacanthus, or five-spined bodian, is about 13 inches long, shape nearly as in the luteus, but rather more slender, colour beautiful deep rose, with a silvery cast on the abdomen; tail deeply forked, the upper lobe stretching beyond the lower; anterior gill-covers armed with five strong spines; it is a native of the Brasilian seas, and is very much esteemed as food. See Plate II. Pisces, fig. 3.

BODKIN, a small instrument made of steel, bone, ivory, &c. used for making holes.

BODY, in physics, an extended solid substance, of itself utterly passive and inactive, indifferent either to motion or rest; but capable of any sort of motion, and of all figures and forms.

Body, in geometry, is a figure extended in all directions, or what is usually said to consist of length, breadth, and thickness. It is usually called a solid. A solid or body is conceived to be formed by the motion of a surface; as a surface is by the motion of a line, and a line by the motion of a point. Similar bodies are in proportion to each other, as the cubes of their sides. There are five bodies which are denominated regular or Platonic bodies; these have all

their sides, angles, and planes similar and equal: they are denominated the

Tetraedron	contained by	4 equilateral triangles
Hexaedron or cube		6 squares
Octaedron		8 triangles
Dodecaedron		12 pentagons
Icosaedron		20 triangles.

In the Plate Miscel. II. fig. 1 to 5, we have given the figures of each, which, if drawn on pasteboard, and cut out by the bounding lines, and then the other lines being half cut through, the parts may be turned up and fastened together by strong paste, so as to form the respective body marked with the corresponding number. Fig. 1 is the teatraedon: fig. 2 the hexaedron: fig. 3 the octaedron: fig. 4 the dodecaedron, and fig. 5 the icosaedron.

To find the superficies or solidity of the regular bodies.

1. Multiply the proper tabular area (taken from the following table) by the square of the linear edge of the solid, for the superficies.

2. Multiply the tabular solidity by the cube of the linear edge, for the solid content.

Table of the surfaces and solidities of the five regular bodies, the linear edge being 1.

No. of Faces	Names	Surfaces	Solidities
4	Tetraedron	1.73205	0.11785
6	Hexaedron	6.00000	1.00000
8	Octaedron	3.46410	0.47140
12	Dodecaedron	20.64573	7.66312
20	Icosaedron	8.66025	2.18169

Bodies, *descent of.* Heavy bodies, in an unresisting medium, fall with an uniformly accelerated motion; whence the spaces descended are in the duplicate ratio of the times and velocity, and increase according to the uneven numbers 1, 3, 5, &c. The times and velocities are in a subduplicate ratio of the spaces. The velocity of descending bodies is, in proportion to the times from the beginning of their fall; and the spaces described by a falling body are, as the squares of the times from the beginning of their fall. See Mechanics.

Body, in law. A man is said to be bound or held in body and goods; that is, he is liable to remain in prison, in default of payment.

In France, all restraints of the body for civil debts are null after four months, unless the sum exceeds two hundred livres.

A woman, though in other respects she cannot engage her person but to her husband, may be taken by the body, when she carries on a separate trade.

Body, among painters; as, to bear a body; a term signifying that the colours are of such a nature, as to be capable of being ground so fine, and mixing with the oil so entirely, as to seem only a very thick oil of the same colour.

But such colours as are said not to bear a body, will readily part with the oil when laid on the work; so that when the colour shall be laid on a piece of work, there will be a separation; the colour in some parts, and the oil in others, except they are tempered extraordinarily thick.

BOEBERA, in botany, a genus of the Syngenesia Superflua class and order. Receptacle naked; down simple; calyx double, the outer many-leaved, inner eight-leaved. One species, found in Carolina and Mexico.

BOEHMERIA, in botany; so called in honour of George Rudolph Boehmer; a genus of the Monoecia Tetrandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character; male, calyx four-parted; corolla none; female, calyx none, but crowded scales between each; germ obovate; style single; seed single, compressed. There are five species; of which B. caudata, is a shrub growing to the height of ten or twelve feet; the leaves are very broad. It is frequent in the cooler mountains of Liguanea, in Jamaica: B. literalis is a native of Hispaniola: B. cylindrica, is an annual plant, with a lucid herbaceous stalk, dividing into several branches; the leaves have three longitudinal veins, and are placed on pretty long foot-stalks; flowers in single catkins, which are not divided. Native of North America and Jamaica.

BOERHAVIA, in botany; so called in honour of the famous Boerhaave; a genus of the Monandria Monogynia class and order. Natural order of Agregatæ: Nyctagenes, Jussieu. Essential character; calyx none; corolla one-petalled, bell-shaped, plaited; seed one, naked, inferior. There are seven species; of these B. erecta; upright flag-weed; has a stem two feet high; at each joint a pair of ovate-pointed leaves,

whitish underneath; on foot-stalks an inch in length; at these joints, which are far asunder, come out also small side branches, growing erect; they, as well as the stem, are terminated by loose panacles of flesh-coloured flowers, succeeded by oblong glutinous seeds. This plant is found at La Vera Cruz, also in the Society Isles.

BOILING. When all other circumstances are the same, the evaporation of liquids increases with their temperature; and after they are heated to a certain temperature, they assume the form of elastic fluids with great rapidity. If the heat be applied to the bottom of the vessel containing the liquids, as is usually the case, after the whole liquid has acquired this temperature, those particles of it which are next the bottom become an elastic fluid first: they rise up, as they are formed, through the liquid, like air bubbles, and throw the whole into violent agitation. The liquid is then said to boil. Every particular liquid has a fixed point at which this boiling commences (other things being the same); and this is called the boiling point of the liquid. Thus, water begins to boil when heated to 212°. It is remarkable, that after a liquid has begun to boil, it never becomes any hotter, however strong the fire be to which it is exposed. A strong heat indeed makes it boil more rapidly, but does not increase its temperature. This was first observed by Dr. Hooke. The following table contains the boiling point of a number of liquids.

Bodies.	Boiling point.
Ether	98°
Ammonia	140
Alcohol	176
Water	212
Muriate of lime	230
Nitric acid	248
Sulphuric acid	590
Phosphorus	554
Oil of turpentine	560
Sulphur	570
Linseed oil	600
Mercury	660

It will be seen when we come to treat of the melting point of solids, that it is capable of being varied considerably by altering the situation of the body. Thus, water may be cooled down considerably lower than 32° without freezing. The boiling point is still less fixed, depending entirely on the degree of pressure to which the liquid to be boiled is exposed. If we diminish the pressure, the liquid boils at a lower temperature; if we increase it, a higher temperature is necessary to produce ebullition. From the experiments of Professor Robinson, it appears that, in a vacuum, all liquids boil about 145° lower than in the open air, under a pressure of 30 inches of mercury; therefore water would boil in vacuo at 67°, and alcohol at 34°. In a Papin's digester, the temperature of water may be raised to 300°, or even 400°, without ebullition; but the instant that this great pressure is removed, the boiling commences with prodigious violence.

BOLETUS, in botany, so called from its globular form, characterized by Linnæus as a horizontal fungus; porous, or punched, with lobes underneath. In the fourteenth edition of the "Systema Naturæ," only twenty-one species are recited, eleven of which are parasitical and stemless, the rest are stipitated. From B. igniarius is prepared the amadou, commonly used on the continent for tinder, to receive the spark struck from the steel by the flint, and the agaric for stopping hæmorrhages in amputations, &c.

BOLT, among builders, an iron fastening fixed to doors and windows. They are generally distinguished into three kinds, *viz.* plate, round, and spring bolts.

Bolts, in gunnery, are of several sorts, as, 1. Transum bolts, that go between the cheeks of a gun-carriage to strengthen the transums. 2. Prise bolts, the large knobs of iron on the cheeks of a carriage which keep the hand-spike from sliding when it is poized up the breech of a piece. 3. Traverse bolts, the two short bolts that being put one in each end of a mortar carriage, serve to traverse her. 4. Bracket bolts, the bolts that go through the cheeks of a mortar, and by the help of quoins keep her fixed at the given elevation. And, 5. Bed bolts, the four bolts that fasten the brackets of a mortar to the bed.

Bolts, in a ship, are iron pins, of which there are several sorts according to their different make and uses. Such are: drive bolts, used to drive out others; ray bolts, with jags or barbs on each side to keep them from flying out of their holes; clench bolts, which are clenched with rivetting hammers; forelock bolts, which have at the end of a forelock of iron driven in to keep them from starting back; set bolts, used for forcing the planks and bringing them close together; fend or fender bolts, made

with long and thick heads, and struck into the uttermost bends of the ship to save her sides from bruises; and, ring bolts, used for bringing to of the planks, and those parts whereto are fastened the breeches and tackles of the guns.

There are various inventions for driving both into ships, and others for drawing them out; we shall describe one by Mr. R. Phillips, for driving copper bolts into ships, for which he received the gold medal from the Society of Arts, &c. in the Adelphi. The instrument employed for driving the bolts consists of a hollow tube formed from separated pieces of cast iron, which are placed upon the heads of each other, and firmly held thereto by iron circles or rings over the joints of the tube; the lowest ring is pointed to keep the tube steady upon the wood; the bolt, being entered into the end of the hole bored in the wood of the ship, and completely covered by the iron tube, is driven forwards within the cylinder by an iron or steel punch placed against the head of the bolt, which punch is struck by a mall; and as the bolt goes farther into the wood, part of the tube is unscrewed and taken off till the bolts are driven home into its place up to the head.

The tubes are about five inches in circumference, and will admit a bolt of seven eights of an inch in diameter.

References to Plate, Life Boats, &c.

Fig. 4. A, the copper bolt, with one end entered into the wood previous to fixing the tube.

B, a piece of timber or ship's side, into which the bolt is intended to be driven.

Fig. 5. C, C, C, C, the parts of the iron tube fastened together, ready to be put on the bolt A.

D, D, D, D, iron or brass rings, with thumb screws placed over the joints of the tube to hold them firm together.

E, E, E, E, the thumb screws, which keep the rings and tube firm in their proper places.

F, two points formed on the lower ring, they are to stick into the timber, and to enable the tube to be held firm in its place.

Fig. 6. Shews the separation of the parts of the tube, which is effected by slackening the thumb screws and rings.

To put them together, you slide the rings over the joints placed as close as possible, then by tightening the thumb screws you will have them firm together, and may continue the tube to any length from one foot to whatever number is required.

Fig. 7. G, H, two steel punches or drifts, to be placed on the head of the copper bolt within the tube whilst driving. The blow given upon the punch drives forward the bolt. The shortest of them should be used first, and when driven nearly to its head should be taken out of the tube, and the longer punch applied in its place.

BOLTONIA, in botany, so called in honour of Mr. James Bolton of Halifax, a genus of the Syngenesia Polygama Superflua. Natural order of Compositæ Oppositifoliæ. Essential character: calyx common subimbricate, with linear scales; corolla radiate; germs compressed, vertical; down obscurely toothed, two-horned; receptacle honey-combed. There are two species, *viz.* B. asteroides, starwort-flowered boltonia; and B. glastifolia, glaucous-leaved boltonia. Both these are natives of America, and flower late in the autumn.

BOMB, in artillery, a shell or hollow ball of cast-iron, having a large vent, by which it is filled with gunpowder, and which is fitted with a fuze or hollow plug to give fire by when thrown out of a mortar, &c.: about the time when the shell arrives at the intended place, the composition in the pipe of the fuze sets fire to the powder in the shell, which blows it all in pieces, to the great annoyance of the enemy, by killing the people or firing the houses, &c. They are now commonly called shells, simply, in the English artillery.

These shells or bombs are of various sizes, from that of 17 or 18 inches diameter downwards. The very large ones are not used by the English, that of 13 inches diameter being the highest size now employed by them: the weight, dimensions, and other circumstances of them, and the others downwards, are as in the following table.

Diameter of the shell.	Weight of the shell.	Powder to fill them.	Powder to burst them in most pieces.
	lbs.	lb. oz.	lb. oz.
13 inch	195	9 $4\frac{1}{2}$	7 8
10	89	4 $14\frac{1}{2}$	3 4
8	46	2 $3\frac{1}{2}$	2 0
$5\frac{4}{5}$ Royal	$14\frac{1}{2}$	1 $1\frac{1}{2}$	0 14
$4\frac{3}{5}$ Cohorn	$7\frac{1}{2}$	0 8	0 7

Mr. Muller gives the following proportion for all shells. Dividing the diameter of the mortar into 30 equal parts, then the

other dimensions in 30ths of that diameter will be thus:

Diameter of the bore or mortar...	30
Diameter of the shell..................	$29\frac{1}{2}$
Diameter of the hollow sphere.....	21
Thickness of metal at the fuze hole	$3\frac{1}{2}$
Thickness at the opposite pert......	5
Diameter of the fuze hole...........	4
Weight of shell empty...............	$\frac{10}{117}d$
Weight of powder to fill it..........	$\frac{2}{473}d$

Where *d* denotes the cube of the diameter of the bore in inches. But shells have also lately been made with the metal all of the same thickness quite around.

In general, the windage or difference between the diameter of the shell and mortar is $\frac{1}{60}$th of the latter; also the diameter of the hollow part of the shell is $\frac{7}{10}$th of the same.

Bombs are thrown out of mortars or howitzers; but they may also be thrown out of cannon; and a very small sort are thrown by the hand, which are called granados.

BOMB *chest*, a kind of chest filled usually with bombs, sometimes only with gunpowder, placed under ground to tear and blow it up into the air with those who stand upon it. It was formerly set on fire by means of a saucisse fastened at one end, but is now much disused.

BOMB *ketch*, a small vessel built and strengthened with large beams for the use of mortars at sea.

BOMBARD, a piece of ordnance anciently in use, exceedingly short and thick, and with a very large mouth. There have been bombards which have thrown a ball of 300 pound weight. They made use of cranes to load them.

BOMBARDIER, a person employed about a mortar. His business is to drive the fusee, fix the shell, load and fire the mortar, and to work with the fire-workers on all sorts of fire-works, whether for war or recreation.

BOMBARDMENT, is the act of assaulting a city or fortress by throwing shells into it, in order to set it on fire, or otherwise demolish it. As one of the effects of the shell results from its weight, it is never discharged as a ball from a cannon, that is, by pointing it at a certain object: the mortars in England are fixed at an elevation of 45°.

BOMBARDO, a musical instrument of the wind kind, much the same as the bassoon, and used as a base to the hautboy.

BOMBASINE, a name given to two sorts of stuffs, the one of silk and the other, crossed, of cotton.

BOMBAX, in botany, English *silk cotton*, a genus of the Monadelphia Polyandria. Natural order of Columniferæ; Malvaceæ Jussieu. Essential character; calyx five-cleft; stamina five or more; capsule woody, five-celled, five-valved; seeds woolly; receptacle five-cornered. There are four species, of which we shall notice the B. ceiba as being the most interesting: it grows to a great size in both Indies; it is one of the tallest trees in those countries; the wood is very light and not much valued except for canoes; their trunks are so large as, when hollowed, to make very large ones. In Columbus's first voyage it was related that a canoe was seen at the island of Cuba made of one of these trees, which was ninety-five palms long, of a proportional width, and capable of containing one hundred and fifty men. The canoes now made in the West Indies from this tree frequently carry from fifteen to twenty hogsheads of sugar, from six to twelve hundred weight each, the average about twenty-five tons burthen. When sawn into boards, and then well saturated with lime-water, the wood bears exposure to the weather many years; it is also formed into laths for roofs, curing pots, and hogshead heading. When the tree decays it becomes a nest for the macaca beetle, the caterpillar of which, gutted and fried, is esteemed by many persons one of the greatest delicacies.

BOMBIC *acid*, in chemistry. The silk-worm forms an acid liquor which was supposed to be an acid of a peculiar nature, and accordingly received, in the new nomenclature, the name of bombic acid; but Mr. Murray thinks that this and some other acids formed by insects, as that by the ant, which is named formic acid, are acetic acid slightly disguised.

BOMBYLIUS, in natural history, a genus of insects of the order Diptera: the generic character is, mouth furnished with a very long porrected, setaceous, bivalve trunk, with horizontal valves, including setaceous piercers. The insects of this genus have somewhat the appearance of the smaller kinds of humble-bees; thickly covered with erect downy hair; they fly with much rapidity, and may sometimes be observed to hang, as if suspended, over a flower, in the manner of some of the spinges, rapidly vibrating their wings and darting off on the least disturbance to a considerable distance. There are forty-

eight species according to Gmelin. The most common and therefore the most worthy attention are the B. medius, B. major, and B aureus. The medius may be seen in the early periods of spring in the gardens and the fields, and is easily distinguished by its downy bee-like body, and its straight sharp-pointed proboscis. Its colour is pale chesnut-brown, with whitish yellow hair; and the wings are blackish along the whole length of the upper half, the remainder being transparent and marked with numerous black spots. The major resembles the medius, but the wings are said to be without spots, being only marked by the black upper division. The Linnæan characters of these two species are not, according to Shaw, sufficiently distinct: B. aureus is hairy; thorax brown; abdomen golden, from which it derives its name. It is found in Barbary. The head is covered with golden-coloured hairs; the sides of the thorax are lined with golden-coloured hairs; abdomen with tufts of hairs; wings brownish at the base, the tip whitish, with six black dots; legs testaceous.

This genus is separated into three divisions, *viz.* A. distinguished by two hairy feelers; antennæ united at the base: B. sucker with three incumbent bristles; no feelers; antennæ approximate: C. antennæ distant, the last joint subulate, and two feelers.

BOMBYX. See PHALÆNA.

BONA *fides*, or BONA *fide*, among lawyers, is as much as to say, such a thing was done really, without either fraud or deceit.

A man is said to possess any thing *bona fide*, who is ignorant of that thing's being the property of another; on the contrary, he is said to possess a thing *mala fide*, who is conscious of its being the property of another.

BONA *notabilia*, are such goods as a person dying has in another diocese besides that wherein he dies; amounting to the value of 5*l.* at least; in which case the will of the deceased must be proved, or administration granted in the court of the archbishop of the province, unless by composition, or custom, any dioceses are authorised to do it, when rated at a greater sum.

BONA *patria*, an assise of countrymen, or good neighbours, where twelve or more are chosen out of the country to pass upon an assise, being sworn judicially in the presence of the party.

BOND, an obligatory instrument, or deed, in writing, whereby one binds himself to another to pay a certain sum of money, or perform some certain acts; as that the obligor shall make a release, execute a sufficient conveyance of his estate, save the obligee harmless, perform the covenants of a deed, &c.

A bond contains an obligation with a penalty, and a condition generally written under it, which expressly mentions the sum that is to be paid, or other thing to be performed, and to whom, with the limited time thereof, for which the obligation is peremptorily binding.

The condition of a bond must be to do something lawful; for if it be to perform an act *malum in se*, as to kill a person, &c. it is void: likewise bonds not to use trades, &c. are unlawful and void: so also are bonds made by compulsion, by infants, and *feme coverts*, &c. but if a drunken man voluntarily gives his bond, it shall bind him; and a bond, though it be without any consideration, is binding. Where a bond has no date, or a false one is inserted therein, if it be sealed and delivered, it is a good bond; and a person shall not be charged by any bond, though signed and sealed, without delivery or words, or other thing, amounting to it. Notwithstanding a bond be made to pay money on the 30th of February, and there be no such day, the bond is good, and the money shall be paid presently. It is the same if no time is limited; in that case it must be immediately paid, or in convenient time.

If a bond be of twenty years standing, and no demand is proved to be made thereon, or good cause shown for so long forbearance, upon pleading the payment at the day, it shall be intended paid.

BOND, *post obit*, is one that becomes payable after the death of some person, whose name is specified in it. The life of a person being uncertain, the risk attached to such bonds frees them from the shackles of the common law of usury.

BOND, in carpentry, a term among workmen; as, to make good bond, means that they should fasten the two or more pieces together, either by tenanting, mortising, or dovetailing, &c.

BONE. By bones are meant those hard, solid, well-known substances, to which the firmness, shape, and strength of animal bodies are owing; which, in the larger animals, form, as it were, the ground-work upon which all the rest is built. In man, in quadrupeds, and many other animals, the bones are situated below the other parts, and scarcely any of them are exposed to view; but shell-fish and snails have a hard

covering on the outside of their bodies, evidently intended for defence.

The bones are the most solid part of animals. Their texture is sometimes dense, at other times cellular and porous, according to the situation of the bone. They are white, of a lamellar structure, and not flexible nor softened by heat. Their specific gravity differs in different parts. That of adults' teeth is 2.27 : the specific gravity of children's teeth is 2.08. It must have been always known that bones are combustible, and that when sufficiently burnt, they leave behind them a white porous substance, which is tasteless, absorbs water, and has the form of the original bone. The nature of this substance embarrassed the earlier chemists. But in 1771, Scheele mentioned, in his dissertation on fluor spar, that the earthy part of bones is phosphate of lime. This discovery was the first and the great step towards a chemical knowledge of the composition of bones. The component parts of bones are chiefly four; namely, the earthy salts, fat, gelatine, and cartilage. The earthy salts may be obtained either by calcining the bone to whiteness, or by steeping it for a sufficient length of time in acids. In the first case the salts remain in the state of a brittle white substance; in the second, they are dissolved, and may be thrown down by the proper precipitants. These earthy salts are four in number: 1. Phosphate of lime, which constitutes by far the greatest part of the whole. 2. Carbonate of lime. 3. Phosphate of magnesia, lately discovered by Fourcroy and Vauquelin. It occurs in the bones of all the inferior animals examined by these indefatigable chemists, but could not be detected in human bones. 4. Sulphate of lime, detected by Mr. Hatchett in a very minute proportion. The proportion of fat contained in bones is various. By breaking bones in small pieces, and boiling them for some time in water, Mr. Proust obtained their fat swimming on the surface of the liquid. It weighed, he says, one-fourth of the weight of the bones employed. This proportion appears excessive, and can scarcely be accounted for without supposing that the fat still retained water. The gelatine is separated by the same means as the fat, by breaking the bones in pieces and boiling them long enough in water. The water dissolves the gelatine, and gelatinizes when sufficiently concentrated. Hence the importance of bones in making portable soups, the basis of which is concrete gelatine, and likewise in making glue. When bones are deprived of their gelatine by boiling them in water, and of their earthy salts by steeping them in diluted acids, there remains a soft white elastic substance, possessing the figure of the bones, and known by the name of cartilage. From the experiments of Hatchett, it appears that this substance has the properties of coagulated albumen. This cartilaginous substance is the portion of the bone first formed. Hence the softness of these parts at first. The phosphate of lime is afterwards gradually deposited, and gives the bone the requisite firmness. The gelatine and fat, especially the first, gave the bone the requisite degree of toughness and strength; for when they are removed, the bone becomes brittle. The relative proportion of phosphate of lime and cartilage differ exceedingly in different bones and in different animals. Ox bones, according to the analysis of Fourcroy and Vauquelin, are composed of

Solid gelatine	51
Phosphate of lime............	37.7
Carbonate of lime..........	10
Phosphate of magnesia...	1.3
	100.0

See Anatomy.

BONIS *non amovendis*, in law, is a writ directed to the Sheriffs of London, &c. charging them, that a person, against whom judgment is obtained, and prosecuting a writ of error, be not suffered to remove his goods until the error is determined.

BONNET, in fortification, a small work, consisting of two faces, having only a parapet with two rows of palisadoes, of about ten or twelve feet distance: it is generally raised before the saliant angle of the counterscarp, and has a communication with the covered way, by a trench cut through the glacis, and palisadoes on each side.

Bonnet, in the sea-language, denotes an addition to a sail: thus they say, lace on the bonnet, or shake off the bonnet.

BONNETIA, in botany, so called in honour of M. Charles Bonnet, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-parted, two parts larger; corol five-petalled, three smaller upright, two longer declinate; capsules oblong, three-celled, three-valved, many seeded. There is only one species, *viz.* B. mahuria grows in marshy places in Cayenne and Guiana, a tree about fifteen feet high, branching chiefly towards the top. The flowers are borne on terminal spikes, and are of a purple colour.

BONTIA, in botany, so called from Jacobus Bontius, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Essential character: calyx five-parted; corol two-lipped; lower lip three-parted, revolute; drupe ovate, one-seeded, with the end oblique. There is but one species *viz.* B. daphnoides, the leaves of which are thick and rather stiff, very smooth and green on both sides; corolla yellowish, with a line of dusky purple along the middle of the lower lip; birds grow fat upon the fruits, but unless the entrails are taken out as soon as the bird is killed, it becomes too bitter to be eaten.

BOOK, *liber*, the composition of a man of wit and learning, designed to communicate somewhat he has invented, experienced, or collected, to the public, and thence to posterity; being withal of a competent length to make a volume.

In this sense, a book is distinguished from a pamphlet, by its greater length; and from a tome or volume, by its containing the whole writing. According to the ancients, a book differed from an epistle, not only in bulk, but in that the latter was folded, and the former rolled up; not but that there are divers ancient books now extant, under the names of epistles.

By 8 Anne, c. 19, the author of any book, and his assigns, shall have the sole liberty of printing and reprinting the same for fourteen years, to commence from the day of the first publication thereof, and no longer; except that if the author be living, at the expiration of the said term, the sole copyright shall return to him for other fourteen years: and if any other person shall print, or import, or shall sell or expose it to sale, he shall forfeit the same, and also one penny for every sheet thereof, found in his possession. But this shall not expose any person to the said forfeitures, unless the title thereof shall be entered in the register book of the Company of Stationers.

By statute eleven copies of each book, on the best paper shall, before publication, be delivered to the warehouse-keeper of the Company of Stationers, for the use of the Royal Library, the libraries of the two universities in England, the four universities in Scotland, the library of Sion College, the library belonging to the College of Advocates in Edinburgh, the library of Trinity College, Dublin, and the King's Inn, Dublin, on pain of forfeiting the value thereof, and also five pounds.

By Stat. 34 Geo. III. c. 20, and 41 Geo. III. c. 107, persons importing for sale books first printed within the united kingdom, and reprinted in any other, such books shall be seized and forfeited; and every person so exposing such books to sale, for every such offence shall forfeit the sum of ten pounds. The penalties not to extend to books not having been printed for twenty years.

By the act of union, 40 Geo. III. c. 67, all prohibitions and bounties on the export of articles (the produce and manufacture of either country) to the other shall cease; and a countervailing duty of two-pence for every pound weight avoirdupois of books, bound or unbound, and of maps or prints, imported into Great Britain directly from Ireland, or which shall be imported into Ireland from Great Britain, is substituted.

Books, *materials of.* Several sorts of materials were used formerly in making books: plates of lead, and copper, the bark of trees, bricks, stone, and wood were the first materials employed to engrave such things upon, as men were willing to have transmitted to posterity. Josephus speaks of two columns, the one of stone, the other of brick, on which the children of Seth wrote their inventions and astronomical discoveries: Porphyry makes mention of some pillars, preserved in Crete, on which the ceremonies, practised by the Corybantes in their sacrifices, were recorded: Hesiod's works were originally written upon tables of lead, and deposited in the temple of the Muses, in Bœotia: the ten commandments, delivered to Moses, were written upon stone; and Solon's laws, upon wooden planks. Tables of wood, box, and ivory, were common among the ancients: when of wood, they were frequently covered with wax, that people might write on them with more ease, or blot out what they had written. The leaves of the palm-tree were afterwards used instead of wooden planks, and the finest and thinnest part of the bark of such trees, as the lime, the ash, the maple, and the elm; from hence comes the word *liber*, which signifies the inner bark of the trees; and as these barks were rolled up, in order to be removed with greater ease, these rolls were called *volumen*, a volume; a name afterwards given to the like rolls of paper or parchment.

Thus we find books were first written on stones, witness the decalogue given to Moses: then on the parts of plants, as leaves chiefly of the palm tree; the rind

and bark, especially of the tilia, or phillyrea, and the Egyptian papyrus. By degrees wax, then leather, were introduced, especially the skins of goats and sheep, of which at length parchment was prepared: then lead came into use; also linen, silk, horn, and lastly, paper itself.

BOOKS, *form of.* The first books were in the form of blocks and tables: but as flexible matter came to be wrote on, they found it more convenient to make their books in the form of rolls: these were composed of several sheets fastened to each other, and rolled upon a stick, or umbilicus; the whole making a kind of column, or cylinder, which was to be managed by the umbilicus as a handle, it being reputed a crime to take hold of the roll itself: the outside of the volume was called *frons;* the ends of the umbilicus, *cornua*, horns, which were usually carved, and adorned with silver, ivory, or even gold and precious stones; the title συλλαβος, was struck on the outside; the whole volume, when extended, might make a yard and a half wide, and fifty long. The form which obtains among us is the square, composed of separate leaves; which was also known, though little used by the ancients.

BOOKS, in a mercantile sense, or BOOK-*keeping*, the several registers wherein merchants and other dealers keep their accounts.

A merchant's books should exhibit the true state of his affairs. They should shew the particular success of each transaction, as well as the general result of the whole; and should be so arranged as to afford correct and ready information upon every subject for which they may be consulted.

Merchants' books are kept either by single, or according to the method of double entry. They who keep them in the former method have occasion for few books, as a journal, or day-book; and a ledger, or post book: the former to write all the articles following each other as they occur in the course of their business; and the other to draw out the accounts of all the debtors and creditors on the journal. This method is only proper for retail dealers, or at least for traders who have but very little business: but as for wholesale dealers and great merchants, who keep their books according to the double entry, or Italian method, as is now most commonly done, their business requires several other books, the usefulness of which will be seen from what follows.

The most considerable books, according to the method of double entry, are the waste-book, the journal, and the ledger; but besides these three, which are absolutely necessary, there are several others, to the number of thirteen, or even more, called subservient or auxiliary books, which are used in proportion to the business a man has, or to the nature of the business a man carries on. These books are the cash-book, the debt-book, the book of numeros, the book of invoices, the book of accounts current, the book of commissions, orders, or advices, &c.

The waste-Book may be defined a register, containing an inventory of a merchant's effects and debts, with a distinct record of all his transactions and dealings, in a way of trade, related in a plain simple stile, and in order of time as they succeed one another.

The waste-book opens with the inventory, which consists of two parts; first, the effects, that is, the money a merchant has by him, the goods he has in hand, his part of ships, houses, farms, &c. with the debts due to him; the second part of the inventory is the debts due by him to others: the difference between which, and the effects, is what the merchants call neat stock. When a man begins the world, and first sets up to trade, the inventory is to be gathered from a survey of the particulars that make up his real estate; but ever after is to be collected from the balance of his old books, and carried to the new.

After the inventory is fairly related in the waste-book, the transactions of trade come next to be entered down; which is a daily task to be performed as they occur. The narrative ought to exhibit transactions with all the circumstances necessary to be known, and no more. It should contain the names of persons with whom the merchant deals upon trust, the conditions of bargains, the terms of payment, the quantity, quality, and prices of goods, with every thing that serves to make the record distinct, and nothing else. The waste-book, if no subsidiary books are kept, should contain a record of all the merchant's transactions and dealings in a way of trade; and that not only of such as are properly and purely mercantile, but of every occurrence that affects his stock, so as to impair or increase it, such as private expences, servants fees, house-rents, money gained, &c.

The journal, or day-book, is the book wherein the transactions recorded in the waste-book are prepared to be carried to

the ledger, by having their proper debtors and creditors ascertained and pointed out: whence it may be observed, that the great design of the journal is to prevent errors in the ledger: again, after the ledger is filled up, the journal facilitates the work required in revising and correcting it; for first the waste-book and journal are compared, and then the journal and ledger; whereas to revise the ledger immediately from the waste-book, would be a matter of no less difficulty, than to form it without the help of a journal: lastly, the journal is designed as a fair record of a merchant's business; for neither of the other two books can serve this purpose; not the ledger, by reason of the order that obtains in it, and also on account of its brevity, being little more than a large index: nor can the waste-book answer this design, as it can neither be fair nor uniform, nor very accurate, being commonly written by different hands, and in time of business. Hence it is, that in case of differences between a merchant and his dealers, the journal is the book commonly called for, and inspected by a civil judge.

In the journal, persons and things are charged debtors to other persons and things as creditors; and in this it agrees with the ledger, where the same style is used, but differs from it as to forms and order; so that it agrees with the waste-book in those very things where it differs from the ledger; and on the other hand it agrees with the latter in the very point wherein it differs from the former.

It may be observed, that every case or example of the waste-book, when entered into the journal, is called a journal post, or entrance; thus the examples above make three direct posts.

Accounts in the ledger consist of two parts, which in their own nature are directly opposed to, and the reverse of one another, and are therefore set fronting one another, and on opposite sides of the same folio. Thus all the articles of the money received, go to the left side of the cash account; and all the articles or sums laid out are carried to the right. In like manner the purchase of goods is posted to the left side of the accounts of the said goods, and the sale or disposal of them to the right.

Transactions of trade or cases of the waste-book, are also made up of two parts, which belong to different accounts, and to opposite sides of the ledger, *e. g.* If goods are bought for ready money, the two parts are the goods received, and the money delivered; the former of which goes to the left side of the account of the said goods, and the latter to the right side of the cash account.

The two parts in any case in the waste-book, when posted to the journal, are denominated the one the debtor, the other the creditor of that post; and when carried from thence to the ledger, the debtor, or debtor part, is entered upon the left side (hence called the debtor side) of its own account, where it is charged debtor to the creditor part: again, the creditor, or creditor part, is posted to the right side, or creditor side of its account, and made creditor by the debtor part. Hence Italian book-keeping is said to be a method of keeping accounts by double entry, because every single case of the waste-book requires at least two entrances in the ledger, *viz.* one for the debtor, and another for the creditor.

From what has been said, it is evident that the terms debtor and creditor are nothing more than marks or characteristics stamped upon the different parts of transactions in the journal, expressing the relation of these parts to one another, and shewing to which side of their respective accounts in the ledger they are to be carried.

Having thus far explained the meaning of the terms debtor and creditor, we shall now proceed to the ledger, or principal book of accounts.

Of the ledger. The ledger is the principal book wherein all the several articles of each particular account, that lie scattered in other books, according to their dates, are collected, and placed together in spaces allotted for them, in such a manner, that the opposite parts of every account are directly set fronting one another, on opposite sides of the same folio.

The ledger's folios are divided into spaces for containing the accounts, on the head of which are written the titles of the accounts, marked Dr. on the left hand page, and Cr. on the right: below which stand the articles, with the word *To* prefixed on the Dr. side, and the word *By* on the Cr. side; and upon the margin are recorded the dates of the articles, in two small columns allotted for that purpose. The money columns are the same as in other books: before them stand the folio column, which contains figures, directing to the folio where the corresponding ledger-entrance of each article is made; for every thing is twice entered in the ledger,

viz. on the Dr. side of one account, and again on the Cr. side of some other account; so that the figures mutually refer from the one to the other, and are of use in examining the ledger. Besides these columns, there must be kept in all accounts, where number, measure, weight, or distinction of coins is considered, inner columns, to insert the quantity; and for the ready finding any account in the ledger, it has an alphabet, or index, wherein are written the titles of all accounts, with the number of the folio where they stand.

How the ledger is filled up from the journal. 1. Turn to the index, and see whether the Dr. of the journal-post, to be transported, be written there; if not, insert it under its proper letter, with the number of the folio to which it is to be carried. 2. Having distinguished the Dr. and the Cr. sides, as already directed, recording the dates, complete the entry in one line, by giving a short hint of the nature and terms of the transaction, carrying the sum to the money columns, and inserting the quantity, if it be an account of goods, &c. in the inner columns, and the referring figure in the folio column. 3. Turn next to the Cr. of the journal-post, and proceed in the same manner with it, both in the index and ledger; with this difference only, that the entry is to be made on the Cr. side, and the word *By* prefixed to it. 4. The post being thus entered in the ledger, return to the journal, and on the margin mark the folios of the accounts, with the folio of the Dr. above, and the folio of the Cr. below, and a small line between them thus $\frac{2}{4}$. These marginal numbers of the journal are a kind of index to the ledger, and are of use in examining the books, and on other occasions. 5. In opening the accounts in the ledger, follow the order of the journal; that is, beginning with the first journal-post, allow the first space in the ledger for the Dr. of it, the next for the Cr. the third for the Dr. of the following post, if it be not the same with some of those already opened, and so on till the whole journal be transported; and supposing that, through inadvertency, some former space has been allowed too large, you are not to go back to subdivide it, in order to erect another account in it.

Though these rules are formed for simple posts, where there is but one Dr. and one Cr. yet they may be easily applied to complex ones.

Cash book. This is the most important of the auxiliary books. It is so called, because it contains, in debtor and creditor, all the cash that comes in, and goes out of a merchant's stock. The receipts on the debtor's side; the persons of whom it was received, on what, and on whose account, and in what specie: and the payments on the creditor's side; mentioning also the specie, the reasons of the payments, to whom, and for what account they are made.

Book of debts, or payments, is a book in which is written down the day on which all sums become due, either to be received or paid, by bills of exchange, notes of hand, merchandises bought or sold, or otherwise. By comparing receipts and payments, one may, in time, provide the necessary funds for payments, by getting the bills, notes, &c. due to be paid, or by taking other precautions.

Book of numeros, or wares. This book is kept in order to know easily all the merchandises that are lodged in the warehouse, those that are taken out of it, and those that remain therein.

Book of invoices. This book is kept to preserve the journal from erasures, which are unavoidable in drawing up the accounts of invoices of the several merchandises received, sent out, or sold; wherein one is obliged to enter very minute particulars. It is also designed to render those invoices easier to find than they can be in the waste-book, or journal.

Book of accounts current. This book serves to draw up the accounts which are to be sent to correspondents, in order to settle them in concert, before they are balanced in the ledger; it is properly a duplicate of the accounts current, which is kept to have recourse to occasionally.

The other mercantile books, as the book of commissions, orders, or advices; the book of acceptances of bills of exchange; the book of remittances; the book of expences; the copy-book of letters; the book of postage; the ship-books, and the book of workmen, require no description. To these may be added others, which depend on the greater or lesser accuracy of the merchants and bankers, and on the several kinds of trade carried on by particular dealers.

BOOK-*binding*, the art of gathering and sewing together the sheets of a book, and covering it with a back, &c. It is performed thus: the leaves are first folded with a folding-stick, and laid over each other in the order of the signatures; then beaten on a stone with a hammer, to make them smooth,

and open well, and afterwards pressed. While in the press they they are sewed upon bands, which are pieces of cord or packthread; six bands to a folio book; five to a quarto, octavo, &c. which is done by drawing a thread through the middle of each sheet, and giving it a turn round each band, beginning with the first, and proceeding to the last. After this the books are glued, and the bands opened and scraped, for the better fixing the paste-boards; the back is turned with a hammer, and the book fixed in a press between two boards, in order to make a groove for fixing the pasteboards; these being applied, holes are made for fixing them to the book, which is pressed a third time. Then the book is at last put to the cutting-press, betwixt two boards, the one lying even with the press, for the knife to run upon, the other above it, for the knife to run against: after which the paste-boards are squared.

The next operation is the sprinkling the leaves of the book, which is done by dipping a brush into vermilion and sap-green, holding the brush in one hand, and spreading the hair with the other; by which motion the edges of the leaves are sprinkled in a regular manner, without any spots being bigger than the others.

Then remains the covers, which are either of calf-skin, or of sheep-skin; these being moistened in water, are cut out to the size of the book, then smeared over with paste made of wheat flour, and afterwards stretched over the paste-board, on the outside, and doubled over the edges withinside; after having first taken off the four angles, and indented and platted the cover at the head-band: which done, the book is covered, and bound firmly between two bands, and then set to dry. Afterwards it is washed over with a little paste and water, and then sprinkled fine with a brush, unless it should be marbled; when the spots are to be made larger, by mixing the ink with vitriol. After this the book is glazed twice, with the white of an egg beaten, and at last polished with a polishing-iron passed hot over the glazed cover.

BOOKSELLER, one who trades in books, whether he prints them himself, or gives them to be printed by others.

Booksellers are in many places ranked among the members of universities, and entitled to the privilege of students, as at Tubingen, Saltsburg, and Paris, where they have always been distinguished from the vulgar and mechanical traders, and exempted from divers taxes and impositions laid upon other companies.

The traffic of books was anciently very inconsiderable, in so much, that the book-merchants both of England, France, and Spain, and other countries, were distinguished by the appellation of stationers, as having no shops, but only stalls and stands in the streets. During this state, the civil magistrates took little notice of the booksellers, leaving the government of them to the universities, to whom they were supposed more immediate retainers; who accordingly gave them laws and regulations, fixed prices on their books, examined their correctness, and punished them at discretion.

But when, by the invention of printing, books and booksellers began to multiply, it became a matter of more consequence, and the sovereigns took the direction of them into their own hands; giving them new statutes, appointing officers to fix prices, and grant licences, privileges, &c. Authors frequently complain of the arts of booksellers. Lord Shaftsbury gives us the process of a literary controversy blown up by the booksellers. The publication of books depend much on the taste and disposition of booksellers. Among the German writers, we find perpetual complaints of the difficulty of procuring booksellers: many are forced to travel to the book fairs at Frankfort or Leipsic, to find booksellers to undertake the impression of their works.

BOOM, in the sea language, a long piece of timber with which the clue of the studding-sail is spread out; and sometimes the boom is used to spread or boom out the clue of the mainsail.

Boom denotes also a cable stretched athwart the mouth of a river or harbour; with yards, topmasts, battling or spars of wood lashed to it, to prevent an enemy's coming in.

BOOPIS, in botany, *bull's eye*, a genus of the Syngenesia Segregata class and order. Calyx one-leaved, many-parted, many-flowered; florets tubular; receptacle chaffy; seeds each involved in its proper calycle, and crowned with its permanent teeth. Two species.

BORAGO, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aspenefoliæ. Essential character; corolla rotated; throat closed with rays. There are five species. B. of-

ficinalis, common borage, is rough with white stiff prickly hairs; calyx divided to the very base, as is also the corolla, but it falls off in one piece; tube very short and white; segments acute. The common colour of the corolla is blue; but it varies to flesh-coloured and white. It is a biennial plant, flowering from May to August. Borage was formerly in great request, being reckoned one of the four cordial flowers. The whole herb is succulent and mucilagenous, having a faint smell when bruised. The juice affords a true nitre. This plant came originally from Aleppo.

BOOT *topping*, in naval affairs, signifies the operation of scraping off the grass, slime, shells, &c. which adhere to the bottom of the ship, near the surface of the water, and daubing it over with a mixture of tallow, sulphur, and resin; it is chiefly performed where there is no dock or other commodious situation for careening, or when the hurry of a voyage renders it inconvenient to have the whole bottom cleansed.

Boot *tree*, or Boot *last*, an instrument used by shoemakers to widen the leg of a boot. It is a wooden cylinder slit into two parts, between which, when it is put into the boot, they drive by main force a wedge or quoin.

BOOTES, a constellation of the northern hemisphere, consisting of 23 stars, according to Ptolemy's catalogue; and of 45, in Mr. Flamstead's catalogue.

BORACIC *acid*. See Borax.

BORASSUS, in botany, a genus of plants the characters of which are not well ascertained. Class Appendix Palmæ, Linnæus. Essential character; corolla three-parted; male stamina six; female styles three; drupe three-seeded. There is but one species, with its varieties; *viz.* B. flabelliformis, has a dark-coloured bark; the wood is a dark-brownish red, and has a soft pith in the middle; fronds decussate on the top of the trunk; stipe near six feet in length, flat, and a little hollow, with rough spines along the edges; below, near a span in breadth; above, not more than a palm; the leaf part is large, and folded like a fan or umbrella, for which purpose it is used. The male and female flowers are on different trees, which have been considered as distinct species. This tree is from twenty-five to thirty feet in height, two feet thick at bottom and one at top. The fruit is as large as a child's head. Wine and sugar are made from the sap of this palm. It is a native of Ceylon, the coast of Coromandel, Java, &c.

BORATES, salts formed with the boracic acid. See the next article.

BORAX, in chemistry, is a name given to a species of white salt much used by various artists. Its use in soldering metals appears to have been known to Agricola. Borax is found mixed with other substances in Thibet. It seems to exist in some lands adjacent to lakes, from which it is extracted by water, and deposited in those lakes; whence in summer, when the water is shallow, it is extracted and carried off in large lumps. Sometimes the water in these lakes is admitted into reservoirs, at the bottom of which, when the water is exhaled by the summer's heat, this salt is found. Hence it is carried to the East Indies, where it is in some measure purified and crystallized; in this state it comes to Europe, and is called tineal. In other parts of Thibet, it seems, by accounts received from China, they dig it out of the ground at the depth of about two yards, where they find it in smaller crystalline masses.

Borax, or sub-borate of soda. This salt, the only one of the borates which has been accurately examined, is supposed to have been known to the ancients, and to be the substance denominated chrysocolla by Pliny. At any rate, it is mentioned by Geber as early as the ninth century, under the name of borax. Its composition was first pointed out by Geoffroy, in 1732, and Baron, in 1748. Bergman demonstrated that it has an excess of base, and is therefore in the state of a sub-borate.

Borax purified, may be obtained crystallized in hexangular prisms, of which two sides are much broader than the remainder, and terminated by triangular pyramids; it is of a white colour: its specific gravity is 1.740: it converts vegetable blues to green: its taste is styptic and alkaline; it is soluble in twenty times its weight of water, of the temperature of 60°, and six times its weight of boiling water: when exposed to the air, it effloresces slowly and slightly: when heated, it swells, loses about four-tenths of its weight, becomes ropy, and then assumes the form of a light, porous, and very friable mass, known by the name of calcined borax; in a strong heat it melts into a transparent glass still soluble in water. When two pieces of borax are struck together in the dark, a flash of light is emitted. This

salt, according to Bergman, is composed of

Acid	39
Soda	17
Water	44
	100

Though borax has been in common use for nearly three centuries, it was only in 1702 that Homberg, by distilling a mixture of borax and green vitriol, discovered the boracic acid. He called it narcotic or sedative salt, from a notion of his that it possessed the properties indicated by these names. Geoffroy afterwards discovered, that borax contained soda; and, at last, Baron proved, by a number of experiments, that borax is composed of boracic acid and soda; that it may be reproduced by combining these two substances; and that therefore the boracic acid is not formed during the decomposition of borax, as former chemists had imagined, but is a peculiar substance which pre-existed in that salt. This acid for purposes of experiment, is obtained from the purified borax of commerce, by one of the following processes: 1. To a solution of borax, in boiling water, add half its weight of sulphuric acid, previously diluted with an equal quantity of water. Evaporate the solution a little; and, on cooling, shining, scaley crystals will appear, which consist of boracic acid. Let them be well washed with distilled water, and dried on filtering paper. 2. Let any quantity of borax be put into a retort, with half its weight of sulphuric acid, and half its weight of water. Boracic acid may be obtained by distillation, and may be purified by washing in water, &c. as before. Boracic acid has the following qualities: 1. It has a solid form, is destitute of smell, and nearly so of taste: 2. It fuses, when heated, and loses its water of crystallization. If the heat be increased suddenly, before it has lost its water of crystallization, it sublimes; but, otherwise, it melts into a glass, which is permanent in the strongest fire: 3. It is soluble in twelve parts of cold water, and in three or four of boiling water: 4. This solution reddens vegetable blue colours, and effervesces with alkaline carbonates: 5. It is soluble in alcohol, and the solution burns with a beautiful green flame: 6. It combines with alkalies and earths; but the only important combination which it forms is with soda.

BORBONIA, in botany, so called from Gaston Bourbon; a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character; calyx acuminate, spiny; stigma emarginate; legume mucronate. There are six species. B. ericifolia, is a small subvillose shrub, with small ovate linear leaves, nerveless, smooth above, villose beneath, revolute; heads sessile, with small flowers. These plants grow naturally at the Cape of Good Hope, where they rise to the height of ten or twelve feet; but they are seldom more than four or five in Europe.

BORDURE, in heraldry, a cutting off from within the escutcheon all round it about $\frac{1}{5}$th of the field, serving as a difference in a coat of arms, to distinguish families of the same name, or persons bearing the same coat.

BORE, among engineers, denotes the diameter of the barrel of a gun or cannon, or rather its whole cavity.

Bore, *square*, among mechanics, a square piece of well-tempered steel, fitted into a handle, serving to widen holes, and make them perfectly round.

BOREALIS. See the article Aurora.

BORELLI (J. Alphonso) a celebrated philosopher and mathematician, born at Naples the 28th of January, 1608. He was professor of philosophy and mathematics in some of the most celebrated universities of Italy, particularly at Florence and Pisa, where he became highly in favour with the princes of the house of Medicis. But having been concerned in the revolt of Messina, he was obliged to retire to Rome, where he spent the remainder of his life under the protection of Christina, Queen of Sweden, who honoured him with her friendship, and by her liberality towards him softened the rigour of his hard fortune. He continued two years in the convent of the regular clergy of St. Pantaleon, called the "Pious Schools," where he instructed the youth in mathematical studies. And this study he prosecuted with great diligence for many years afterwards, as appears by his correspondence with several ingenious mathematicians of his time, and the frequent mention that has been made of him by others, who have endeavoured to do justice to his memory. He wrote a letter to Mr. John Collins, in which he discovers a great desire and endeavours to promote the improvement of those sciences; he also speaks of his correspondence with, and great affection for, Mr. Henry Oldenburgh, Secretary of the Royal Society; and Dr. Wallis; and of the then late learned Mr. Boyle. He died

of a pluerisy in his 72d year, December 31, 1679. His principal work was "De Motu Animalium," in two volumes small 4to. The object of this work was to explain the functions of animal bodies, on mechanical principles. He describes the fibres of the muscles, and measures the power or force which each possesses, and the power of them collectively. He points out in what manner that power is increased or diminished, by the manner in which the fleshy fibres are joined to the tendons. He calculates the power of the heat, in propelling the blood, which he supposed equal to 180,000 pounds weight. In his calculations Borelli was found to have erred in many respects, but his principles were generally admitted.

BORER, an instrument invented for the purpose of searching or exploring the nature of soils, it consists of iron rods about six feet long, made to screw into one another: to the lower one is fixed a steel point: with an instrument of this kind two men will easily sound the depth of 12 feet in a quarter of an hour, if they do not meet with stones. When the rod becomes too heavy to be conveniently managed with the hand, it may be raised by a rope fastened at one end to the handle, and at the other to a roller, or kind of windlass, erected at a proper height, perpendicularly over the hole, and turned with one or two handles. The toughest iron is used for making this instrument, which should be well hammered, till its surface is quite smooth and even, for the least roughness and inequality would occasion a friction, that must greatly retard its working. For the same reason, and also to increase the force of its fall, it is necessary that it should be perfectly straight, nor should it ever be struck with a mallet, &c. to force it down, because a blow might bend it, and it would easily break afterwards. A bit, like that of an augre, proportioned to the thickness of the rod, may at any time, when necessary, be substituted instead of the steel point to draw up a sample of the substance from the very bottom of the sounding.

BORING, in a general sense, the art of perforating, or making a hole through any solid body.

Boring, in mineralogy, a method of piercing the earth with scooping irons, which, being drawn back at proper times, bring up with them samples of the different strata through which they have passed; by the examination of which the skilful mineralogist will be able to guess whereabouts a vein of ore may lie, or whether it will be worth while to open a mine there or no.

Boring *of water-pipes*. The method of boring alder poles for water-pipes is thus: being furnished with poles of a fit size, horses or tressels are procured of a due height, both to lay the poles, and rest the augre on in boring; they also set up a lathe, whereby to turn the lesser ends of the poles, and adapt them to the cavities of the greater ends of others, in order to make the joint shut each pair of poles together. The outer, or concave part, is called the female, and the other, or inner, the male part of the joint. In turning the male part, they make a channel, or small groove in it, at a proper distance from the end; and, in the female part, bore a small hole to fit over this channel; they then bore through their poles, sticking up great nails at each end, to guide them right; but they commonly bore a pole at both ends, so that if it be crooked one way, they can nevertheless bore it through, and not spoil it.

BORONIA, in botany, a genus of the Octandria Monogynia class and order. Calyx four-parted; petals four; antheræ pedicelled below the summits of the filaments; style from the top of the germ very short; stigma capitate; capsule four-united; seeds coated. There are four species natives of New South Wales.

BOROUGH, or Burgh, in a general sense, signifies a town or a corporation, which is not a city. The word, in its original signification, is by some supposed to have meant a company, consisting of ten families, which were bound together at each other's pledge. Afterwards, as Verstegan has it, borough came to signify a town, having a wall or some kind of inclosure round it. And all places that in old times had the name of borough, it is said, were fortified, or fenced in some shape or other. Borough is a place of safety and privilege; and some are called free burghs, and the tradesmen in them free burgesses, from a freedom they had granted to them originally, to buy and sell without disturbance, and exempt them from toll.

Borough is now particularly appropriated to such towns or villages as send burgesses or representatives to parliament, whether they may be incorporated or not.

They are distinguished into those by charter or statute, and those by prescription or custom; the number in England

is one hundred and forty-nine, some of which send one, but the most of them two representatives.

Boroughs, *royal*, in Scotland, are corporations made for the advantage of trade, by charters granted by several of their kings, having the privilege of sending commissioners to represent them in parliament, besides other peculiar immunities. They form a body of themselves, and send commissioners each to an annual convention at Edinburgh, to consult for the benefit of trade, and their general interest.

Borough, *English*, a customary descent of lands or tenements, in certain places, by which they descend to the youngest instead of the eldest son; or, if the owner have no issue, to the younger instead of the elder brother. The custom goes with the land, although there be a devise or feoffment at the common law to the contrary. The reason of this custom, says Littleton, is, because the youngest is presumed, in law, to be least able to provide for himself.

Borough-head, or *headborough*, called also borough-holder, or bursholder, the chief man of the *decenna*, or hundred, chosen to speak and act in behalf of the rest.

Headborough also signifies a kind of head constable, where there are several chosen as his assistants, to serve warrants, &c.

BORROWING, when money, corn, grain, gold, or other commodity, merely esteemed according to its price, is borrowed, it is repaid by returning an equal quantity of the same thing, or an equal value in money. If money is borrowed, it is always understood that interest is payable, and it is by law demandable; but when a house, or a horse, &c. is borrowed, the restoration of the identical property is always understood; or if a thing be used for any other, or more purposes, than those for which it was borrowed, or be lost, the party may have his action on the case for it.

BOS, in zoology, *the ox*, a genus of quadrupeds of the order of Pecora. The generic character is, horns concave, turned outwards, lunated, smooth; front teeth eight in the lower jaw; canine teeth none. B. taurus, the bison, from which the several races of common cattle have been gradually derived, is found wild in many parts, both of the old and the new continent; inhabiting woody regions, and arriving at a size far larger than that of the domestic or cultivated animal. In this its native state of wildness, the bison is distinguished not only by his size, but by the superior depth and shagginess of his hair, which about the head, neck, and shoulders, is sometimes of such a length as almost to touch the ground. His horns are rather short, sharp-pointed, extremely strong, and stand distant from each other at their bases, like those of the common bull. His colour is sometimes of a dark blackish brown, and sometimes rufus brown; his eyes large and fierce; his limbs extremely strong, and his whole aspect in a degree savage and gloomy. See Plate III. Mammalia, fig. 2.

The principal European regions where this animal is at present found, are the marshy forests of Poland, the Carpathian mountains, and Lithuania. Its chief Asiatic residence is the neighbourhood of Mount Caucasus; but it is also found in other parts of the Asiatic world. The American bison seems to differ in no respect from the European, except in being more shaggy, and having a more protuberant bunch or fleshy substance over the shoulders. It grows to a vast size, and has been found to weigh sixteen hundred, and even two thousand four hundred pounds, the strongest man cannot lift one of the skins from the ground. These were the only animals which bore any affinity to the European cattle, on the first discovery of the American continent, and might have been made to answer every purpose of the European cow; but the natives being in a savage state, and living chiefly by chase, had never attempted the domestication of the animal. The common ox is, in reality, the bison reduced to a domestic state; in which, in different parts of the world, it runs into as many varieties as the sheep; differing widely in size, form, and colour, according to climate and other circumstances. Its importance in this its domestic state needs not be mentioned. Formerly the ox constituted the whole riches of mankind; and he is still the basis of the wealth of nations, which subsist and flourish in proportion to the cultivation of their lands and the number of their cattle.

The Urus, or wild bull, is a variety of the ox kind, and is chiefly to be met with in the extensive forests of Lithuania. It grows to a size almost equal to the elephant, and is quite black; the eyes are red and fiery, the horns thick and short, and the forehead covered with a quantity of curled hair; the neck is short and strong, and the skin has an odour of musk. The female,

though not so big as the male, exceeds the largest of our bulls in size : nevertheless her udder is extremely small. Upon the whole, however, this animal, which greatly resembles those of the tame kind, probably owes its variety to its natural wildness, and the richness of the pastures where it is produced. Fig. 1.

The Zebu is another variety of the Bos Taurus. They are all equally docile and gentle when tamed, and are in general covered with fine glossy hair, softer and more beautiful than that of the common cow. Their humps are of different sizes, in some weighing from forty to fifty pounds, but in others less. That part is in general considered as a great delicacy ; and when dressed has much the appearance and taste of udder. Fig. 3.

The Bisons of Madagascar and Malabar are of the great kind; those of Arabia, Petrea, and most parts of Africa, are of the Zebu or small kind. In America, especially towards the North, the bison is well known. They herd together in droves of from one to two hundred, on the banks of the Missisippi, where the inhabitants hunt them, their flesh being esteemed good eating. They all breed with the tame cow. The hump, which is only an accidental characteristic, gradually declines, and in a few generations no vestiges of it remain. Thus, we see, whether it be the wild or the tame ox, the bonasus or the urus, the bison or the zebu, by whatever name they are distinguished, and though variously classed by naturalists, in reality they are the same; and however diversified in their appearance and properties, are descendants of one common stock, of which the most unequivocal proof is, that they all mix and breed with each other. The oxen of India are of different sizes, and are made use of in travelling, as substitutes for horses. Their common pace is soft. Instead of a bit, a small cord is passed through the cartilage of the nostrils, which is tied to a larger cord, and serves as a bridle. They are saddled like horses; and, when pushed, move very briskly: they are likewise used in drawing chariots and carts. For the former purpose white oxen are in great esteem, and much admired. They will perform journies of sixty days, at the rate of from twelve to fifteen leagues a day, and their travelling pace is generally a trot. In Persia there are many oxen entirely white, with small blunt horns, and humps on their backs. They are very strong, and carry heavy burthens. When about to be loaded, they drop down on their knees like the camel, and rise when their burthens are properly fastened.

Bos *babylus*, or *buffalo*, ox with horns lying backwards, turning inwards, and flat on the fore part. In its general appearance, the buffalo is so nearly allied to the common ox, that, without an attentive examination, it might pass for a variety of the same animal. It differs, however, in the form of its horns, and in some particulars relative to its internal structure. The buffalo is rather superior in size to the common ox; the head larger in proportion; the forehead higher; the muzzle of a longer form, but at the same time broad and square: but it is principally the form of the horns that distinguishes the buffalo. They are large, and of a compressed or depressed form, with the exterior edge sharp. The buffalo has an appearance of great strength, and a more ferocious or malignant aspect than the bull; owing to the convexity of his forehead, the smallness of his eyes, the flatness of his muzzle, and the flatter and more inclined position of his horns. The general or prevailing colour of the buffalo is blackish, except the hair on the top of the forehead, and that at the tip of the tail, which is of a yellowish white; the skin itself is also of a black colour; and from this general cast it is but very seldom observed to vary. As the buffalo in his domesticated state is, in general, larger and stronger than the ox, he is employed with advantage in different kinds of labour. Buffaloes are made to draw heavy loads, and are commonly directed and restrained by means of a ring passed through the nose. Two buffaloes yoked, or rather chained, to a cart, are able to draw as much as four strong horses. As they carry their neck and head low, the whole weight of their body is employed in drawing; and their mass much surpasses that of a labouring horse. In its habits the buffalo is much less cleanly than the ox; delighting to wallow in the mud; and, next to the hog, may be considered as the dirtiest of domesticated quadrupeds. His voice is deeper, more uncouth, and hideous, than that of the bull. The milk of the female buffalo is said, by some authors, to be not so good as that of the cow; but it is more plentiful, and is used for the purposes of the dairy in the warmer regions.

Italy is the country where buffaloes are at present most common, in a domesticated state; being used, as in India, both for the

Plate II.

Fig. 1. Bos *taurus : urus or wild bull. Fig. 2. Bison. Fig. 3. Zebu. Fig. 4.* Bos *bubalus. buffalo.*

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dairy and for draught. The district of the Pontine marshes is the spot which may be considered as their principal station. In India this animal is occasionally used for the saddle, as a substitute for the horse.

The buffalo, like other animals of this genus, admits of varieties as to size and figure. Of these, the most remarkable is the small naked Indian buffalo of Mr. Pennant, which is the size of a runt, with a nearly naked body, thinly beset with bristly hair; the rump and thighs quite bare; the first being marked on each side with dusky stripes pointing downwards, the last with two transverse stripes; the horns compressed sideways, taper, and sharp at the point. It is a native of India. Another variety, still smaller, is said to occur in the mountains of the Celebes, which are full of caverns. This variety is of the size of a middling sheep, and is seen in small herds, very wild, and difficult to be taken; and even in confinement are so fierce, that Mr. Pennant records an instance of fourteen stags being destroyed in the space of a single night by one of these animals, which was kept in the same paddock. Fig. 4.

Bos *moschatus*, or *musk ox*, having very long pendant hair, and horns (in the male approximated at the base) bending inwards and downwards, and outwards at the tips. It is a native of North America, where it appears to be a very local animal; being found first in the tract between Churchill river, and that of the Seals, on the west side of Hudson's bay, and is very numerous between the latitudes 66° and 73° north, which is as far as any tribes of Indians go. This animal is but of small size, being rather lower than the deer, but larger or thicker in body. The hair, in the male, is of a dusky red colour, extremely fine, and so long as to trail on the ground, and render the animal a seemingly shapeless mass, without distinction of head or tail; the legs are very short; the shoulders rise into a lump, and the tail is short, being a kind of stump of a few inches only, with very long hairs. Beneath the hair, on all parts of the animal, is a fine cinereous wool, which is said to be more beautiful than silk when manufactured into stockings and other articles. The horns are closely united at the base, bending inwards and downwards; but turning outwards towards the tips, which are very sharp; near the base the horns are two feet in girth, but are only two feet long, when measured along the curvature; the weight of a pair, separated from the head, is sometimes sixty pounds.

Bos *grunniens*, or *yak*, (having, with cylindric horns curving outwards, very long pendant hair, and extremely villose, horse-like tail), is about the height of an English bull, which he resembles in the general figure of the body, head, and legs; it is covered all over with a thick coat of long hair; the head is rather short, crowned with two smooth round horns, which, tapering from the root upwards, terminate in sharp points; they are arched inwards, bending towards each other, but near the extremities are a little turned back.

They are a very valuable property to the tribes of itinerant Tartars, called Duckba, who live in tents, and tend them from place to place: they at the same time afford their herdsmen an easy mode of conveyance, a good covering, and wholesome subsistence. They are never employed in agriculture, but are extremely useful as beasts of burden; for they are strong, sure-footed, and carry a great weight. Tents and ropes are manufactured of their hair; and among the humbler ranks of herdsmen, caps and jackets are made of their skins. Their tails are esteemed throughout the East, as far as luxury and parade have any influence on the manners of the people. In India no man of fashion ever goes out, or sits in form at home, without two chowrabadars, or brushers, attending him, each furnished with one of these tails mounted on silver or ivory handles, to brush away the flies. The Chinese dye them of a beautiful red, and wear them as tufts to their summer bonnets. The yak is the most fearful of animals, and very swift; but when chased by men or dogs, and finding itself nearly overtaken, it will face its pursuers, and hide its hind parts in some bush, and wait for them; imagining that if it could conceal its tail, which was the object they were in search of, it would escape unhurt.

Bos *caffer*, or *Cape ox*, (having the horns very broad at the base, then spreading downwards, next upwards, and at the tips curving inwards); inhabits the interior parts of Africa, north of the Cape of Good Hope, and is greatly superior in size to the largest English ox. It is of a very strong and masculine form, with a fierce and malevolent aspect. Its colour is a deep cinereous brown; the hair on the body is rather short, but that on the head and breast very long, coarse, and black, hanging down

the dew-lap, like that of a bison; from the hind part of the head to the middle of the back is also a loose black mane; the tail is nearly naked at the base; the remainder being covered with long loose hair. These animals are found in large herds, in the desert parts beyond the Cape; and, if met in the narrow parts of woods, are extremely dangerous, rushing suddenly on the traveller, goring and trampling both man and horse under foot. It is also said, that they will often strip off the skin of such animals as they have killed, by licking them with their rough tongues; as recorded by some of the ancient authors of the bison.

BOSCIA, in botany, a genus of the Tetrandria Trigynia class and order. Calyx four-toothed; corolla four-petalled; capsule four-celled. One species found at the Cape.

BOSEA, in botany, from Bose, a senator of Leipsic, a genus of the Pentandria Digynia class and order. Essential character: calyx five-leaved; corolla none; berry one-seeded. There is but one species, *viz.* B. yervamora, golden rod tree, is a strong woody shrub, with a stem as large as a man's leg, the branches come out very irregularly, and make considerable shoots in summer; these branches retain their leaves till spring, when they fall off and new leaves are produced soon after. It is a native of the Canary islands, and is also found in some of the West India islands.

BOSSIÆA, in botany, a genus of the Diadelphia Decandria: calyx two-lipped, the upper lip inversely heart-shaped; banner with two glands at the base; keel of two petals; legume pedicelled, compressed, many-seeded. One species, a native of New Holland.

BOSTRICHUS, in natural history, a genus of insects of the order Coleoptera: antennæ clavate, the club solid; thorax convex, slightly margined; head inflected and hid under the thorax. There are about 30 species. They are a very fertile and voracious tribe, and destructive to woods, making those deep irregular channels, so often observable in the bark and wood of trees. They are found chiefly in Europe and America.

BOTANY, is that science which teaches a knowledge of the vegetable kingdom, as its name, derived from βοτανη, an herb or grass, expresses. This word may be easily traced to its primitive βοω, or βοσκω, to feed, and since plants have ever been regarded as the food of a large portion of animals, the aptness of its derivation is apparent. This study, in its most limited sense, includes the practical discrimination, methodical arrangement, and systematical nomenclature of vegetables; while in a more enlarged view, it comprises the anatomy and functions of their several parts, together with the various qualities and uses which render them serviceable either to mankind or the brute creation. In this respect botany may be considered as a vast and almost boundless study; nor is the merely systematical department of botany, or natural history in general, when cultivated on philosophical principles, inferior to any other science, in extent or utility, as an exercise for the discriminative powers of the mind. The necessity of a regular method of classification, which is calculated to arrange and dispose the whole vegetable kingdom, cannot be doubted, since the most experienced and intelligent botanists of the present day have scarcely been able to reckon, within ten thousand, how many species of plants there may be in the world.

An attention to the vegetables on all sides spread around him, must have been one of the earliest occupations of man in a state of nature; and this attention was doubtless quickened to a further contemplation of their beauty and utility when it was discovered, that independently of affording gratification to the senses, some were provided as an aliment for the body, and that others contained a soothing balm for corporeal sufferings. Hence we may infer, that the study of plants has, through every age and in every clime, excited the attention of mankind; yet it is truly remarked by a late elegant writer, Dr. Pulteney, that, "in the enlightened ages of Greece and Rome, and under the most flourishing state of Arabian literature, botany, as a science, had no existence. Nor was it till some time after the revival of learning, that those combinations and distinctions were effectually discovered, which in the end, by giving rise to system, have raised the study of plants to that rank it holds at present in the scale of knowledge."

In the early history of Britain, we find that herbs were cultivated and studied with considerable assiduity by the Druids, who applied this knowledge with much effect to the purposes of superstition as well as medicine, and thus appropriated to themselves the offices both of priests and phy-

sicians. Historians inform us that the misseltoe was held by our ancestors in such veneration, that it was only allowed to be cut by a priest, and with a golden knife; when thus prepared, it was dispensed as a charm to prevent sterility, and to overcome the fatal effects of poison. We learn from Pliny that various superstitious rites with respect to many other plants were also carefully observed by the Druids. Vervain and savin were among the number; the former of these being used as a means to conciliate friendship, and the latter as an antidote to misfortunes. A small portion of the mountain-ash was believed to act as a charm against the powers of witchcraft, and this idea is still prevalent in the highlands of Scotland, where it is usual to drive cattle with a switch of this tree in order that they may be preserved from the evils of enchantment.

The Saxons appear to have made but little proficiency in the investigation of plants, though some of the Saxon manuscript herbals shew that the study was not altogether disregarded by this people. Their chief aim was to be acquainted with plants in a medicinal point of view. Botany indeed was involved in the utmost obscurity, being merely studied as an auxiliary to astrology, even to the middle of the 16th century, for at that period was published "A Lyttel Herbal of the Properties of Herbs, newly amended and corrected, with certain additions at the end of the boke, declarying what herbs hath influence of certain starres and constellations, whereby may be chosen the best and most lucky times and days of their ministration, according to the Moon being in the signs of Heaven, the which is daily appointed in the almanack; made and gathered in the year M.D.L. xii. Feb. by Anthony Ascham, Physician." London, 1550. 12°.

But from these times of ignorance and barbarism, in which the fairest of sciences was converted to the most foolish of purposes, let us now turn to the contemplation of the first gleams of wisdom that darted through the clouds when rent asunder by the inventors of systematical botany.

Conrad Gesner, at Zurich, and Cæsalpinus, at Rome, towards the end of the 16th century, entirely independent of each other, first conceived the idea of a regular classification of plants by their flowers and fruit, to which, as Dr. Smith has observed, "the very existence of botany, as a science, is owing." Upon this plan various systems have been framed by succeeding botanists, but before we enter upon this subject it will be essential, in the first place, to understand the general anatomy of plants, and lastly, the nature and functions of their particular organs.

It will readily be admitted that the most convenient mode of coming to a knowledge of the anatomy of vegetables, is to begin from their external covering, the *epidermis*, or cuticle. Various theories have been formed respecting its uses to the vegetable body, but physiologists have mostly agreed that it was designed as a guard against the injurious effects of the atmosphere upon the vital parts of plants, since this, as well as the human cuticle, is merely a dead substance. The infinite variety of appearances which the epidermis assumes in different plants is peculiarly striking. It is commonly transparent and smooth; sometimes it is hairy or downy; sometimes of so hard a substance, that even flint has been detected in its composition. Hence the Dutch rush, equisetum hyemale, serves as a file to polish wood, ivory, and even brass.

Under the cuticle is found a substance, which till very lately has been but slightly noticed by physiologists. This is the *cellular integument*, analogous to the rete mucosum of animals; it is like that of a pulpy texture and the seat of colour. It is commonly green in the leaves and stems, and is dependent for its hue on the action of light.

When the cellular integument is removed, the outer surface of the *bark* presents itself, which, in plants or branches that are only one year old, consists of one simple layer, often scarcely separable from the wood. In the branches and stems of trees it consists of as many layers as they are years old; the innermost of these is called the *liber*, or inner bark, in which the vital functions for the season are carried on, and in the meanwhile materials for the new liber are secreted and deposited on the inside; the latter is destined to perform the requisite functions in the ensuing spring, when the last year's liber is united and assimilated to the outer bark as its predecessors had been. It appears also from the experiments and observations of Duhamel, Hope, Knight, and others, that the liber deposits also matter for a new layer of wood. The bark owes its strength and tenacity to innumerable woody fibres, mostly longitudinal, though connected laterally so as to make a kind of net-work. This reticula-

tion is so perfect and beautiful in the daphne laghetto, or lace bark of the West Indies, that it may be stretched laterally into a kind of gauze, sometimes used for articles of ornamental dress. The bark contains, in appropriate vessels, the principal secreted fluids of trees in great perfection. Its medicinal virtues in many instances are familiar to us; the Peruvian bark affords "a cooling draught to the fevered lip;" while that of the cinnamon yields a rich cordial; that which is stripped from the oak is used for the purpose of tanning, for which several other kinds are of inferior utility. When a wound is made in the bark it heals, though slowly, by the lateral extension of the portion which is left.

Immediately under the bark is situated the *wood*, which forms the great bulk of trees and shrubs. This also consists of numerous layers, as any one must have observed in the fir and many other trees. Each of these layers is moreover composed of other thinner ones; their substance consists of innumerable woody fibres, and is perforated by longitudinal sap-vessels, variously constructed or arranged in different trees, and intermixed with other vessels containing secreted fluids or air.

It would be superfluous to enlarge on the economical uses of wood in every country, from the most barbarous to the most refined. Of this material the savage forms his club and his spear, while the civilised part of mankind convert it to the purposes of comfort and luxury. Many conjectures have arisen among philosophers with respect to the manner in which the circular layers of wood are annually formed, and the effects which heat or cold may have on their formation. Cold seems to condense the operation, as well as for a time to interrupt it; since in the trees of hot countries these rings or layers are scarcely perceptible. In many trees more or less of the outermost layers continue for a time of a different colour and texture from the inner ones, and are called by workmen the sap. Such layers are unfit for any lasting service. The laburnum shews them very distinctly, and the oak likewise. It was long a matter of great uncertainty how, or whence each new layer of wood was added to the former ones. Malpighi and Grew, the first physiologists who gave attention to the subject, formed, without any mutual communication, an opinion, which proves to be correct, and to which we have already alluded, that the bark deposited every year from its own substance a new layer of wood. Hales thought this new layer proceeded from the wood of the former year; Linnæus presumed that it was secreted, internally, next to the pith. The experiments of Duhamel and Hope confirmed the sentiments of Grew and Malpighi; and at present there is no kind of doubt upon this subject. A layer of wood being formed every year, it is evident that the age of a sound tree may be known from counting its rings when felled; and it has been observed that hard winters are recorded in this natural register by certain rings being more dense than the rest. In the north side of a tree also they are usually more narrow than on the south; and upon this principle a mode for travellers to find their way through an unknown forest has been suggested, namely, that by felling a tree they might ascertain the points of the compass; but we humbly conceive that much more obvious means for the same purpose are within the reach of every traveller, and that the one recommended is somewhat like telling

> " ——— what hour of the day
> The clock doth strike by algebra."

Within the centre of the wood is the *medulla*, or pith, which is a cellular substance, juicy when young, extending from the roots to the summits of the branches. In some plants, as grasses, it is hollow, merely lining the stem. Linnæus believed this part to be analogous to the nerves of animals, and the immediate cause of the growth and evolution of all their parts; that it was always struggling, as it were, to overcome the resistance of their woody substance, and that it did accordingly elongate itself and cause the increase of the vegetable body in young and tender parts, where that resistance is least. The formation of seeds he conceived only put a final stop to its extension by the production of offspring from it. Facts are not wanting in support of this hypothesis; but there are many more conclusive ones against it. The real use and physiology of the part in question still remains in great obscurity.

OF ROOTS.

In defining the parts of vegetables it is found most commodious to begin from the bottom, proceeding upwards. Hence the *root*, which is the first part produced by a germinating embryo, comes first under consideration. Its presence seems necessary to plants, as it serves to fix and hold them

BOTANY.

Plate I.

1 Fibrous Root, Grass._2 Creeping Root, Mint. 3. Spindleshap'd Root, Radish._4 Abrupt Root, Scabiosa, Succisa._5 Tuberous Root, Potatoe. 6 Bulbous Roots, Onion._& Lilly._7 Granulated Root, Saxifraga Granulata._8 Bud, Horse Chesnut._9 Stem, Bearing leaves & Flowers, Convolvulus. 10 Straw, Grass._11 Stalk, Passion Flower. 12 Flower Stalk. 13 Feet Stalk. 18 Stipula. 19 Bractia. 22 Tendril. 23 Gland.

Couper sculp.

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in the earth, from which they imbibe nourishment through their elementary tubes. Sea-weeds, however, afford an exception to this, for they are nourished by their surface, the root serving only to fix them to a convenient spot.

A root is either annual, biennial, or perennial. The first kind live but one season, as barley; the second survive one winter, and perish at the end of the following summer, after perfecting their seed, like wheat; if, however, any circumstances should prevent their flowering they may live several years till that event takes place. Perennial roots are such as remain and produce blossoms for an indefinite term of years, like those of trees and shrubs in general, and of many herbaceous plants whose stems are annual.

The body of the root is denominated *caudex;* the fibrous, which is the only essential part, *radicula.* This latter is strictly annual in all cases, and is what serves for absorbing the nutritious fluids of the soil. It is necessary for the botanist as well as the farmer and gardener, to be well acquainted with the several kinds of roots, which differ materially in their nature and functions. Those of a fleshy nature most powerfully resist drought, and are, as Dr. Smith has suggested, reservoirs of the vital energy of the vegetable. We have, with the permission of this gentleman, adopted in the following pages those leading ideas upon the subject before us, which are detailed and exexemplified more at length in his "Introduction to Physiological and Systematical Botany," to which work we must refer those of our readers who wish for more deep information than our limits will allow.

Roots are distinguished as follows:

1st. A fibrous root, *radix fibrosa,* consists entirely of fibres, as in many grasses, and a number of annual herbaceous plants. These can but ill bear a continued deprivation of moisture or nourishment. The fibres carry what they absorb directly to the base of the stem. Botany, Plate I. fig. 1.

2nd. A creeping root, *repens,* is a sort of subterraneous stem, spreading horizontally in the ground, throwing out abundance of fibres, as in mint and couch-grass. Weeds furnished with such a root are amongst the most pernicious, being so difficult to eradicate. Nature, however, having furnished them with so powerful a mode of increase is very sparing in the production of their seeds. Fig. 2.

3rd. A spindle-shaped root, *fusiformis,* is common in biennial plants, though not confined to them. The radish and carrot have spindle-shaped roots, producing numerous fibres for the absorption of nutriment. Such roots may be transplanted with great safety in the torpid season of the year. Fig. 3.

4th. An abrupt or stumped root, *præmorsa,* like that of the primrose, is as it were bitten off; hence many plants furnished with it have obtained the whimsical name of devil's-bit. Fig. 4.

5th. A tuberous or knobbed root, *tuberosa,* a very important sort, appears under a great diversity of forms. In the potatoe it consists of fleshy knobs connected by common stalks or fibres; these knobs are biennial, formed in the course of one season, and destined to produce fresh plants the following year. This is the case with the oval or hand-shaped roots of the orchis tribe. Some herbs, indeed, have perennial knobs to their roots. Fig. 5.

6th. A bulbous root, *bulbosa,* consists of a kind of subterraneous bud, being either solid, as in the crocus; tunicate, as in the onion; or scaly, like that of the lily. Fig. 6. These roots, like the knobs above-mentioned, are reservoirs of nourishment, or rather of the vital powers, during the winter. After flowering and leafing their herbage and fibres decay, and the roots may then be removed or kept out of the ground for a time without any hazard. When fresh fibres are formed it is fatal to disturb them.

7th. A granulated root, *granulata,* agrees in physiology with the last, being a cluster of little bulbs or scales connected by a common fibre, as in the white saxifrage and wood sorrel. Fig. 7.

OF BUDS.

Buds of trees have a great analogy with the bulbs and knobs of the roots in herbaceous plants. In them the vital principle is latent till a proper season for its evolution arrives. For this reason buds are essential to the trees or shrubs of cold countries, and are formed in the course of the summer in the bosoms of their leaves. The plane-tree has them concealed in the base of its footstalk, which answers the purpose of protection. In most instances they are guarded by scales, furnished with gum or woolliness as an additional defence. Till buds begin to vegetate they very powerfully resist cold, and are scarcely known to suffer at any season, but it is quite otherwise when they have made ever so slight an effort to develope themselves. Plants are propagat-

ed by buds as commodiously as by roots. Those of one tree may be engrafted on the bark of another of the same species, or one nearly akin, by which, as is well known, valuable varieties are multiplied. Fig. 8.

It is remarkable that nature should permit such devastation and waste as is made by many insects, whose caterpillars or grubs feed on the buds of trees. Several species of fir are infested with their appropriate insects, which, literally speaking, devour their vitals, and should seem to be capable in one season of destroying a whole forest. Yet these are only instruments in the hand of Providence, which, like many others, though formidable in appearance, are never allowed to transgress their due bounds.

OF THE STEMS AND STALKS OF PLANTS.

Botanists reckon seven kinds of stems or stalks of plants.

1. *Caulis*, a stem, fig. 9, properly so called, bears both leaves and flowers, as the trunks and branches of all trees and shrubs, as well as of many herbaceous plants besides. By its means the organs of plants are raised to a commodious height above the ground, and presented in various directions to the atmosphere and light. In germination, it always takes a contrary direction to the root. As it advances in growth, it is either able to support itself, or twines round, or adheres to other bodies. Some stems creep on the ground, and take root here and there, by which the plant is increased. The stem is either simple, as in the lily, or branched as in the generality of plants. When regularly and repeatedly divided, with a flower springing from each division, it is called *caulis dichotomus*, a forked stem. Though generally leafy or scaly, a stem may be naked in plants destitute of leaves altogether, as the creeping cereus, and the genus Stapelia. Climbing stems are of several kinds; as *radicans*, clinging to any other body for support by means of fibres which do not imbibe nourishment; *scandens*, climbing by means of spiral tendrils like the vine and passion-flower; *volubilis*, twining round any thing that comes in its way by its own spiral form, either from left to right, according to the apparent motion of the sun, like the honeysuckle, or from right to left, like the convolvulus and French bean; nor can any art or force make a twining stem turn contrary to its natural direction. In the manner of their growth and branching stems are very various, being either straight, irregularly spreading, or zigzag; either alternately branched or oppositely; two-ranked, when the branches spread in two horizontal directions, or brachiate, four-ranked, when they spread in four directions, crossing each other alternately in pairs. *Caulis determinate ramosus*, an abruptly branched stem, belongs particularly to the heaths, the rhododendron, &c. and is a term invented by Linnæus to express their peculiar mode of growth; each of their branches, after terminating in flowers, throws out a number of fresh ascending shoots from just below the flowering part. The Indian fig has a remarkable jointed stem, whose ovate portions look like leaves; possibly the scales with which they are covered may be equivalent to leaves.

The shape of a stem is either round or two-edged, as in the everlasting pea, or with three, four, or more angles. Square stems are extremely common, and such generally bear opposite leaves. Several stems are winged, the angles being extended into leafy borders, as in thistles.

The surface of the stem is either smooth, rough, warty, viscid, bristly, hairy, downy, woolly, hoary, or glaucous. It is either striated with fine parallel lines or more deeply furrowed; sometimes it is spotted with a purplish hue.

The inner part of the stem is either solid, in which case its centre is occupied with pith; or hollow, and lined with a white shining membrane, of which the hemlock is an example. When the stem is wanting, a plant is called *acaulis*, as is the case with the daisy and primrose. The nature of the stem agrees in many respects with the caudex, or body of the root, at least in trees and shrubs; for such are capable of being propagated by cuttings of their stem or branches, which, when planted, throw out roots. This is not the case, however, with annual stems. Linnæus calls the stems of trees roots above-ground. It is frequently indifferent which end of a cutting is planted in the earth; and the extremity of a branch bent down to the ground in most cases readily takes root, which circumstances confirm his idea.

The stem of several plants is subject to a disease, whence it becomes as it were compound or clustered, forming a broad flat figure, crowded with leaves or flowers at the extremity, and sometimes besprinkled with them at the sides. We have seen it in the ash, holly, broom, nasturtium, wall-flower, toad-flax, &c. A kind of pea is frequently cultivated in Norfolk with red and

white flowers, and a tender eatable pod, called the top-knot pea, in which this variety of stem is regularly propagated by seed.

2. *Culmus*, a straw, or culm, fig. 10, is the peculiar stem of grasses, rushes, and such like plants. It bears both leaves and flowers, and in that respect comes under the denomination of a caulis; but is readily known by its habit, though difficulties attend its definition. In most grasses, corn, &c. it is jointed in a manner peculiar to itself, and then cannot be mistaken; but in common rushes, and some few grasses, it is destitute of joints. When these parts are bent, it is called geniculate, and such joints readily take root.

3. *Scapus*, a stalk, fig. 11, springs immediately from the root, bearing flowers and fruit, but not leaves, as in the primrose and cowslip. It is either simple or branched, naked or scaly. In the cyclamen it becomes spiral after flowering, and buries the seeds in the ground. Dr. Smith has found, contrary to the opinion of Linnæus, that a plant may sometimes be increased by its scapus, as in lachenalia tricolor, which occasionally bears bulbs on its stalk.

4. *Pedunculus*, the flower-stalk, fig. 12, springs from the stem or branches, bearing flowers and fruit, but not leaves. *Pedicellus* is a partial flower-stalk, or, in other words, the ultimate subdivision of a general one. The most common situation of a flower-stalk is axillary, originating from between a leaf and the stem, or between a branch and the latter. It is rarely opposite to a leaf, as in some species of geranium, and still more rarely intermediate between two leaves, as in some kinds of solanum. It is either terminal or lateral: solitary, clustered, or scattered; simple or branched. According to the various modes in which it is subdivided several kinds of inflorescence are distinguished, to be mentioned hereafter. Sessile flowers are such as have no stalk. The flower-stalk is occasionally naked, or furnished with bracteas. Very rarely it bears tendrils.

5. *Petiolus*, the foot-stalk, fig. 13, is applied exclusively to the stalk of a leaf, and is either simple, as in all simple leaves, or compound, as in the greater part of compound ones. Sometimes it bears tendrils. It is generally channelled on the upper side, and more or less dilated at the base; in one or two instances the flower-stalk grows out of it, as in turnera. Leaves that have no foot-stalk whatever are called sessile. The sap-vessels are for the most part very conspicuous in foot stalks, and their spiral coats are easily observed.

6. *Frons*, a frond. This term, which properly means a bough, is technically applied by Linnæus to express the stem, leaf, and fructification being united, that is, the leaf bears the flowers and fruit. The term is only used in the class Cryptogamia. Ferns which bear seeds on the back of their leaf are genuine instances of this, and it is applied to lichens, &c. Plate II. fig. 14.

7. *Stipes*, stipe, is the stem of a frond, fig. 15, or the stalk of a fungus, as in the common eatable mushroom. In the former instance it is very generally clothed with scales of a peculiar chaffy texture; in the latter it is very often invested by a ring formed of the membrane which had previously covered their fructification.

OF THE LEAVES.

The leaf, *folium*, fig. 16 and 17, is a very general organ of vegetables, yet not absolutely necessary to all plants, for the stems and stalks occasionally perform its functions. What those functions are we shall in a compendious manner explain. Leaves are generally so formed as to present a large surface to the atmosphere; when they are of any other hue than green, they are said in botanical language to be coloured. Their duration is for the most part annual, but in some trees and shrubs they survive two or more seasons, and such plants being always in leaf are denominated evergreens. The internal surface of a leaf is highly vascular and pulpy, and is clothed with a cuticle very various in different plants, but its pores are always so constructed as to admit of the requisite evaporation or absorption of moisture, as well as to admit and give out air. Light also acts through this cuticle in a definite manner. That air and moisture and light have considerable, and even the most important effects, upon the leaves of plants, has long been known to those who have studied the subject; that heat and cold affect them is familiar to every one. The experiments of Hales, Bonnet, and others, have thrown much light upon the absorption and perspiration of leaves, while those of Priestley and Ingenhouz have explained their effects upon the atmosphere, and the manner in which air and light particularly act upon them. Leaves have a natural tendency to present their upper surface to the light, and turn that surface towards it in whatever direction it is presented to them. When

trees in leaf are nailed to a wall, and the position of their leaves is consequently disturbed, they soon recover their natural direction. Light evidently acts as a wholesome stimulus to their upper surfaces, and as a hurtful one to the under. When the latter is forcibly presented for a long period to its rays, destruction is the consequence. Leaves seem to require occasional repose from the action of light on their upper surface; for, when it is withdrawn from them, many leaves close or fold themselves together, as if in a state of relaxation, and spread themselves forth again at the returning beams of the morning. This is more especially the case with winged leaves, as those of the pea kind. Those of the white acacia, robinia pseudo-acacia, have been remarked by Bonnet to be over-excited by the sun of a very hot day, and to fold their upper sides together, in a manner directly contrary to their nocturnal posture. The effect of moisture upon leaves every one must have observed. By absorption from the atmosphere, they are refreshed, and by evaporation, especially when separated from their stalks, they soon fade and wither. Aquatic vegetables, whose leaves are immersed in the water, both absorb and perspire with peculiar facility. Anatomical investigations have shewn that the nutritious juices, imbibed from the earth, and become sap, are carried by appropriate vessels into the substance of the leaves. Mr. Knight, in his papers in the Philosophical Transactions, has demonstrated that these juices are returned from each leaf, not into the wood again, but into the bark. Hence a new and curious theory of vegetation has been established. It appears that the sap is carried into the leaves for the purpose of being acted upon by air and light, with the assistance of heat and moisture. By all these agents a most material change is wrought in its component parts and qualities, differing widely according to the diversity of the species. Thus the resinous, oily, mucilaginous, saccharine, bitter, acid, or alkaline secretions are elaborated. The heedless observer of a leaf is little aware of the wonderful operations constantly going on in its delicate substance, nor can the most enlightened philosopher explain more than a very small part of the chemical processes of which it is the immediate agent. It is scarcely necessary to observe how materially plants differ in the flavour and qualities of their leaves, all which must depend in a great measure on the operation of the leaf itself, for the common sap of plants, from which all their secretions are made, differs very little in plants whose qualities are very unlike to each other; those qualities depending upon the secreted fluids elaborated principally by the leaves.

The green colour of the organs in question is easily proved to be almost entirely owing to the action of light. Plants which grow in the dark are of a sickly white, which is the case with any parts artificially or accidentally covered with earth, as in cultivated cellery or asparagus, whose stems and leaf-stalks are purposely managed in this way to render their flavour and appearance more delicate. Such blanched parts soon become green on exposure to light. Leaves are subject to a sort of disease by which they become partially spotted or streaked with white or yellow. In this state they are termed variegated, and occasionally contribute to the ornament of our gardens. The whiteness frequently extends to the leaf-stalk, and sometimes to the branch, as may be seen in the variegated elder. Such varieties are propagated by cuttings, layers, or roots, but not by seed. They appear to be somewhat more tender than the plant in its natural state. One variety of the holly has, in addition to a yellow variegation, a beautiful tinge of purple, but this is a rare instance. In the amaranthus tricolor the leaves are naturally adorned with most beautiful and splendid colours, and in some other species of the same genus, with more uniform and less vivid tints.

The irritable nature of some leaves is remarkable, not but that all leaves may truly be said to possess irritability with respect to light. The phenomena however to which we now allude are of the most striking kind. The sensitive plant, mimosa pudica, common in hot-houses, when touched by any extraneous body, folds up its leaves one after another, while their foot-stalks droop as if dying. After a while they recover themselves again. Each leaf of the dionæa muscipula, or Venus's fly-trap, is furnished with a pair of toothed lobes, which, when touched near the base, fold themselves together and imprison any insect that may be in their way. It is presumed that the air evolved by the body of the dead insect may be wholesome to the plant, for leaves are known to purify air impregnated with carbonic acid gas, produced from the breathing of animals or the burning of a candle. The sarracenia, of which several species from America are now cultivated in our more

curious gardens, bears tubular leaves, which retain water in their hollows, and imprison insects, whose putrifying bodies evidently produce a quantity of bad air, and analogy leads us to suppose that air is destined to be serviceable to the constitution of the vegetable. See Dr. Smith's Introduction, page 195.

Many important botanical distinctions are founded upon the situations and forms of leaves. These are explained by the following terms.

Folia radicalia, are radical leaves, as in the primrose.

F. *caulina*, stem leaves, and *ramea*, branched leaves. The situation of the latter is either alternate, opposite, scattered, or clustered. Several leaves standing round a stem or branch are termed *verticillata*, whorled; such are either ternate, quaternate, or quinate, &c.

F. *imbricata*, imbricated, lie one over the other like tiles upon a house.

F. *decussata*, cross each other in pairs alternately, as in many plants with opposite leaves.

F. *disticha*, two-ranked, spread in two directions like the yew.

F. *secunda*, unilateral, lean all towards one side. Some leaves are erect, others reflexed or recurved; but the greater part spread more or less horizontally. A few are obliquely twisted, and still fewer are reversed, *resupinata*, what should be the upper surface becoming the under, as in the beautiful alstræmeria. Curt. Mag. t. 139.

F. *petiolata* are such as stand on footstalks; *sessilia*, sessile leaves, grow immediately from the branch or root without any stalk.

F. *peltata*, peltate leaves, have the footstalk inserted into their centre, like the handle of a shield to which the name alludes, witness the common nasturtium, trapæolum.

F. *amplexicaulia* clasp the stem or branch with their base.

F. *decurrentia* run down the same part in the form of a leafy border, as in many thistles.

F. *connata* are united at their base.

F. *perfoliata* have the stem running through them, as in hair's-ear, bupleurum rotundifolium.

F. *vaginantia* sheath the stem or each other, as in most grasses.

F. *equitantia* clasp each other in two opposite rows, being compressed at the base, as in many common species of iris.

The form of leaves is either simple, as in grasses, lilies, &c. or compound, as in parsley, elder, roses, &c. Simple leaves are either *integra*, undivided, like those just mentioned, or lobed like the vine, hollyhock, and many others.

The following forms of simple leaves respect their outline only.

Folium orbiculatum, as nearly circular as possible, which is very rare.

Subrotundum, roundish, is much more common.

Ovatum, ovate, the shape of an egg, very frequent.

Obovatum, obovate, the same figure with the broad end uppermost.

Ellipticum, or *ovale*, elliptical, or oval, being broadest in the middle.

Oblongum, oblong, several times longer than broad, without any very decided form.

Spatulatum, spatulate, of a roundish figure, tapering into an oblong base.

Cuneiforme, wedge-shaped, broad at the summit, tapering down to the base.

Lanceolatum, lanceolate, narrow and oblong, tapering towards each end, a very common sort of leaf, as in willows.

Lineare, linear, narrow, with parallel sides, like most grasses.

Acerosum, needle-shaped, linear, and evergreen, generally acute and rigid, as in the fir, juniper, &c.

Triangulare, *quadrangulare*, *quinquangulare*, express the number of angles, without any allusion to their measurement.

Deltoides, trowel-shaped, or deltoid, has three angles, of which the terminal one is the most acute.

Rhombeum, rhomboid, nearly square.

Reniforme, kidney-shaped, as that of the asarabacca.

Cordatum, heart-shaped, which is extremely common.

Lunulatum, crescent-shaped, whether the points are directed backwards or forwards.

Sagittatum, arrow-shaped, triangular, with the posterior angles much elongated.

Hastatum, halbert-shaped, triangular, the lateral lobes spreading horizontally.

Panduriforme, fiddle-shaped, as in the fiddle dock.

Runcinatum, runcinate, or lion-toothed, cut into several transverse acute reflexed segments, like the dandelion.

Lyratum, lyrate, or lyre-shaped, cut into several transverse segments, gradually larger towards the extremity of the leaf, which is dilated and rounded.

Fissum, cloven, when the fissures are linear or straight.

Lobatum, lobed, when the segments are rounded.

Sinuatum, sinuated, cut into rounded, dilated openings.

Partitum, deeply divided, almost to the base.

Laciniatum, laciniated, cut into various irregular portions, as if torn.

Incisum, and *dissectum*, express somewhat of a more regular kind of division.

Palmatum, palmate, cut into several oblong segments, leaving an entire space at the base.

Pinnatifidum, pinnatifid, cut into several transverse parallel segments.

Bipinnatifidum, doubly pinnatifid.

Pectinatum, pectinate, pinnatifid with remarkably narrow segments, like the teeth of a comb.

Inequale, unequal or oblique, when the two halves of a leaf are unequal, and their bases not parallel.

A leaf in its termination is either *truncatum*, abrupt; *præmorsum*, jagged-pointed, having various irregular notches, as if bitten; *retusum*, ending in a broad shallow notch; *emarginatum*, with a small acute notch; *obtusum*, ending in a segment of a circle; *acutum*, terminating in an acute angle; *acuminatum*, having a taper point; *obtusum cum acunine*, blunt with a small point; *mucronatum*, or *cuspidatum*, tipped with a spine; or *cirrosum*, tipped with a tendril.

A leaf, with regard to its margin, is either *integerrimum*, entire, as in the lilac; for it must be observed, that *integrum* means an undivided leaf; *spinosum*, beset with prickles, as in thistles, which is opposed to *inerme; ciliatum*, fringed with soft hairs; *cartilagineum*, hard and horny; *dentatum*, toothed; *serratum*, serrated, the teeth, like those of a saw, pointing forwards; *serrulatum*, minutely serrated; *crenatum* and *crenulatum*, notched with little rounded scallops, as in ground ivy; *erosum*, jagged; *repandum*, wavy; *glandulosum*, glandular; *revolutum*, having the margin turned or rolled backwards, of which *involutum* is the reverse; or *conduplicatum*, having the margins folded together.

A leaf, as to its disk, is either *rugosum*, rugged; *bullatum*, blistery; *plicatum*, plaited, like a fan; *undulatum*, waved obtusely up and down; *crispum*, elegantly curled and twisted, which is generally a preternatural luxuriance; *concavum*, hollow in the middle; *venosum*, veiny; *nervosum*, ribbed, the principal veins or ribs extending in simple lines from the base to the point; *avenium*, without veins; *enerve*, without ribs; *trinerve*, three-ribbed; *triplinerve*, triply-ribbed, when the lateral ribs branch off above the base; *basi trinerve*, when the base is cut away close to the lateral ribs, as in burdock.

A few other terms relating to leaves in general deserve mention. F. *carnosum* is a fleshy leaf, such as belongs to those called succulent plants. The internal pulp of these seems to have no share in their peculiar functions as leaves: but to be a reservoir of moisture, and some degree of vitality. F. *nudum* means a leaf destitute of all clothing or hairiness whatever: the same term applied to a stem means that it bears no leaves, and to a flower, that it has no calyx. F. *tubulosum* is a tubular leaf, as in several species of allium; *lobelia dortmanna* has a leaf formed of a double tube; *canaliculatum* expresses a leaf with a longitudinal furrow; *carrinatum*, one with a prominent line like a keel at its back; *ensiforme*, the sword-shaped or two-edged leaf of the irises; *alcinatum* is used by Dr. Smith "when the first leaves of a plant give place to others totally different from them, and from the natural habit of the genus, as in many mimosæ of New Holland;" the first leaves of these are pinnated, the subsequent ones dilatations as it were of the naked foot-stalks; *appendiculatum* is used by the same author for a leaf "furnished with an additional organ for some particular purpose," as in dionæa muscipula above-mentioned, and nepenthes destillatoria, the leaf of which bears a sort of covered pitcher full of water. We omit to particularize the more common terms which are to be found every where.

Compound leaves come principally under the following denominations.

F. *digitatum* is when several leaflets, or partial leaves, stand on the summit of a common foot-stalk. Such are either two, three, or more. F. *pinnatum*, a pinnate leaf, is composed of leaflets ranged laterally on the foot-stalk; when it has no terminal leaflet it is said to be abruptly pinnate; sometimes a tendril takes place of the odd leaflet, as in the pea and vetch. The leaflets are either opposite or alternate: sometimes they are interrupted by an intermediate series of smaller ones, as in spiræa filipendula, dropwort. F. *lyrato-pinnatum* resembles a lyrate leaf, as in the turnip. F. *auriculatum* is a simple leaf, with a pair of

auricles or leaflets at its base. F. *pedatum* has three primary leaflets, of which the lateral ones are lobed in their fore part, as in helleborus fœtidus. The different degrees in which leaves are compounded are thus expressed: F. *compositum* is simply compound; *decompositum*, doubly compound; *supra decompositum*, thrice compound, or more; of all which the umbelliferous tribe afford examples; *bigeminatum* and *tergeminatum* are twice and thrice paired; *ternatum* consists of three leaflets; *biternatum* is twice ternate, and *triternatum*, thrice ternate. In the same manner *pipinnatum* is doubly pinnate, and *tripinnatum* triply pinnate.

OF THE FULCRA, OR APPENDAGES OF PLANTS.

There are various appendages to the herbage of plants, all which are comprehended by Linnæus under the term *fulcrum*, a prop or support, which term, in its literal sense, however, applies but to a few of these organs.

1. *Stipula.* This is a leafy appendage to the true leaves, or to their stalks, for the most part in pairs, more or less constant even in the same genus or species: in roses they are invariable; in willows very much the contrary. Some species of Cistus have stipulas, others none. The peculiar stipula of grasses is a membrane crowning the sheathes of their leaves and embracing their stem, but it is not found in all the species. Plate I. fig. 18.

2. *Bractea*, is a leafy appendage to the flower or its stalk, conspicuous in the lime-tree, beautifully coloured in the purple or pink-topped clary, and very much diversified in different plants. Fig. 19.

3. *Spina*, a thorn, proceeds from the wood itself, as in the wild pear-tree, which loses its thorns by cultivation. This is fancifully expressed by Linnæus, who calls such garden plants tamed, or deprived of their natural arms.

4. *Aculeus*, a prickle, proceeds from the bark only, having no connection with the wood, as in the rose, bramble, &c. It might be expected that this should be less permanent than the foregoing, but the reverse is the case, for prickles are not effaced by culture. They rather abound most upon the most luxuriant stems. Plate II. fig. 21.

5. *Cirrus*, a tendril or clasper, is really intended as a support for weak stems, by which they are enabled to climb rocks, or the trunks of lofty trees. These organs are either simple or branched, straight in the first instance, but soon becoming spiral, and thus are rendered capable of taking hold of any thing that comes in their way; especially as many of them are so constructed, that after having made a certain number of turns, they perform as many in a contrary direction. Some attach themselves by a dilatation of their extremities to the smoothest and hardest stone. Thus, the vine, the passion-flower, and the family of vetches are elevated to a considerable height above the ground. Such tendrils differ essentially from roots, in never imbibing nourishment, any more than the short fibres of the ivy. The gloriosa, or superb lily, has a spiral tendril at the end of each leaf, and in some few plants the flower-stalks produce tendrils. Plate I. fig. 22.

6. *Glandula*, a gland, is a small tumour secreting a sweet, resinous, or fragrant liquor, as on the calyx of the moss-rose, the foot-stalks of passion-flowers whose glands are like little cups, and the leaf of salix pentendra; which last being pressed between paper, leaves the impression of an elegant row of yellow dots. Fig. 23.

7. *Pilus*, a hair. Fig. 24. Under this are included all the various kinds of pubescence; bristles, wool, &c. some of which are curious objects for the microscope. Some few of these bristles discharge a poison, as in the nettle, causing great irritation, whenever they are touched in such a manner as for their points to wound the skin. Hence arose the following lines:

> "Tender-handed touch a nettle,
> And it stings you for your pains;
> Grasp it like a man of mettle,
> And it soft as silk remains."

OF THE DIFFERENT KINDS OF INFLORESCENCE OR MODES OF FLOWERING.

The various modes in which flowers are situated upon or connected with a plant, are of great botanical importance, not only for specific distinctions, but as leading the way to a knowledge of natural families or orders. Yet Linnæus does not allow them to enter into the generic characters of plants, which he founds solely on the seven parts of fructification to be hereafter described. This is one of those classical maxims of the Linnæan school, which rival botanists are continually attempting to undermine and depreciate, conscious of their own deficiency in that technical skill for which Linnæus was pre-eminent. We shall take occasion to mention an instance in which he himself went counter to this law.

The following are the several kinds of inflorescence.

1. *Verticillus*, a whorl, in which the flowers surround the stem in a garland or ring, though perhaps merely inserted on its two opposite sides, as in the natural order to which the mints, the dead nettle, Lamium, and many others belong. Fig. 25.

2. *Racemus*, a cluster or raceme, bears several flowers, each in its own stalk, loosely ranged along one common stalk, like a bunch of currants, and this common stalk may be either simple or branched. A racemus is generally drooping or pendulous, and the flowers are all nearly in perfection at once. Fig. 26.

3. *Spica*, a spike, is composed of numerous crowded flowers, ranged along an upright common stalk, expanding progressively and properly, destitute of any partial stalks; but this last circumstance cannot be rigidly observed. Wheat and barley are good examples of a genuine spike. Some lavenders have a compound spike. *Spicula*, a spikelet, is a term used only for grasses, and expresses that assemblage of florets in a common calyx which constitutes their flowers. Fig. 27.

4. *Corymbus*, a corymb, fig. 28, may be called a flat-topped spike, the long stalks of whose lowermost flowers raise them to a level with the uppermost, or nearly so; this is exemplified in the cabbage and wall-flower. The yarrow and mountain-ash bear a kind of compound and irregular corymbus, to which is nearly allied,

5. *Fasciculus*, a fascicle, expressive of a close bundle of flowers, on little stalks variously connected and level at the top, as in the sweet-william. Fig. 29.

6. *Capitulum*, a head or tuft, is composed of numerous sessile flowers, collected into a globular form, as the globe amaranthus and thrift. Fig. 30.

7. *Umbella*, an umbel or rundle, consists of several stalks, called rays, spreading from one common centre, like an umbrella. Each stalk is either simple and single-flowered, or, as most commonly occurs, subdivided into an *umbellula*, or partial umbel. This inflorescence belongs to a natural order, thence called *Umbellatæ*, to which the parsley, carrot, hemlock, and many others belong. Fig. 31.

8. *Cyma*, a cyme, consists of stalks springing from one common centre, but which are afterwards irregularly subdivided, as in the laurustinus and elder, fig. 32. Linnæus was led by some considerations to reckon these two last forms of inflorescence as aggregate flowers, but it is found more correct to esteem them modes of inflorescence, though by so doing we lose the advantage of taking parts properly belonging to the umbel into the generic character. By a contrary mode of proceeding we presume to think Linnæus swerved from his own rule of founding his genera on the actual parts of fructification.

9. *Panicula*, a panicle, Plate III. fig. 33, is a loose subdivided bunch of flowers, arranged without order, as in the oat. It is either close or spreading. When its branches lean all towards one side, it is called *Panicula secunda*.

10. *Thyrsus*, a bunch, is a very dense panicle, inclining to an ovate figure, of which Linnæus cites the lilac and butterbur as instances. Dr. Smith adds to these a bunch of grapes, which appears to him to have been inaccurately reckoned a racemus. Fig. 34.

OF THE FRUCTIFICATION OF PLANTS.

Under the term fructification are comprehended not only all the parts of the fruit but also those of the flower, which last are indispensable for the perfecting of the former. All these organs are, therefore, essential to a vegetable, which may be deficient in any of those that we have previously described, but can never be totally destitute of those by which its species is propagated from generation to generation; for propagation by cuttings, buds, or roots, is only the extension of an individual, the life and vigour of which gradually wears out unless it be reproduced from seed. The fructification is, therefore, well defined by Linnæus as "a temporary part of vegetables, terminating the old individual and beginning the new."

The parts which constitute these essential organs are seven. 1. *Calyx*, fig. 35, the flower-cup, or external covering of the flower. This also is of seven kinds: 1. *Perianthium*, or calyx, properly so called when it is contiguous to and makes a part of the flower, as the five green leaves which encompass a rose, including their urn-shaped base. 2. *Involucrum*, which is remote from the flower, as in the umbelliferous tribe; but if the idea of these plants as above expressed be just, the part in question ought rather to be considered as a *bractea*. 3. *Amentum*, a catkin, is formed of numerous scales attached to one cylindrical receptacle, and falling off with it: in catkins which bear seed the scales are often enlarged and hardened into a cone, as in the fir. 4. *Spatha*, a sheath,

bursts longitudinally, and is more or less remote from the flower, as in the snow-drop, narcissus, and arum. 5. *Gluma*, a husk, is the peculiar chaffy calyx of grasses and their allies; to it belongs the arista or awn, which however is not constant in the same species of grass or corn: an elegant feathery awn is seen in the stipa pennata, feather-grass. 6. *Perichætium*, a scaly sheath, investing the fruit-stalk in some mosses, as hypnum. 7. *Volva*, the wrapper of the Fungus tribe, is either of a membranous kind sheltering their fructification, as in the common mushroom, or more coriaceous, investing the base of their stalk as in many fungi.

2. *Corolla*, fig. 36, the delicate, generally coloured, leaves of a flower, is always situated within the calyx when both are present. This term comprehends both the petal, *petalum*, and the nectary, *nectarium*. A flower consists of one petal, or of several, the former denominated monopetalous is either campanulate, funnel-shaped, salver-shaped, wheel-shaped, ringent like the mouth of an animal, or personate, closed by a palate. Its parts are the tube and the limb. A polypetalous corolla is either cruciform, as in a wall-flower, rosaceous, papilionaceous, as in the pea kind, or incomplete, when some parts are found in analogous flowers are wanting. The parts of a polypetalous corolla are the claw and the border. The great point to be considered with respect to the corolla in general is, whether it be regular or irregular; in some flowers, however, it varies in the same species from one shape to the other, witness the genera antirrhinum and bignonia.

Neither the calyx nor corolla is indispensably necessary to a flower. Both are wanting in hippuris, and one or other is deficient in many genera. Hence botanists are led into a perplexity how, in some cases, to denominate the part which is present. When its green colour and thick texture agree with the generality of flower-cups, we do not hesitate to esteem it such; but a calyx is often beautifully coloured, and there is some doubt whether the splendid leaves of tulips and lilies be not a true calyx; at least they answer to the Linnæan definition, that their parts are opposite to the stamens, whereas those of a corolla should be alternate with the latter. The Linnæan hypothesis, however, though sanctioned by Jussieu, of the corolla proceeding from the inner bark, and the calyx from the outer, is entirely subverted by recent and more correct observations on vegetable physiology. The functions of these two parts are perhaps, though similar, not exactly analogous. Those of the calyx probably resemble what are performed by the leaves, and this part is presumed by Dr. Smith even to secrete woody matter for strengthening the fruit-stalk. The corolla, indeed, seems destined to answer some exclusive purpose to the essential organs of impregnation with regard to air and light. It fades when they wither, and is altogether of temporary duration.

Nectarium, the nectary, fig. 37, is frequently a part of, or an appendage to the corolla; sometimes the petal itself secretes honey; sometimes a set of glands perform this function; and in other cases there is a peculiar petal-like apparatus for preparing or holding the nectarious juice. Linnæus has remarked that plants whose nectary is distinct from the petals are commonly poisonous, which in general holds good with those of the more elaborate nectaries. A German writer, named Sprengel, has proved the corolla to be in many instances an attraction as well as accommodation for insects in their search after honey: he remarks certain spots, called by him *maculæ indicantes*, which he conceives are designed to direct these little animals to their prey. The scent of flowers may perhaps contribute to the same end. There can be no doubt that the use of the honey is to attract insects, to promote the impregnation of the flower, and not, as some have thought, for the nourishment of the seeds or other organs, being frequently quite out of the reach of both.

3. *Stamina*, fig. 38, the stamens, are situated withinside of the corolla, and are various in number in different flowers, from one to several hundreds. These are the essential organs of impregnation. A stamen usually consists of two parts, *filamentum*, the filament, and *anthera*, the anther, the latter of which only is essential. Its most common shape is oblong, composed of two cells or cavities, which burst by a longitudinal fissure on the outside. A more unusual structure is when the anther opens by pores towards the summit, as in the genus erica, or heath, of which such a profusion of beautiful species from the Cape of Good Hope enriches our green-houses. Some of their anthers, moreover, are furnished with variously formed and very elegant crests and spurs, which afford the botanist marks for discriminating the species. The genus of firs, Pinus, has a jagged crest to its anthers, which serves also to distinguish some of the difficult species from each other. The situation of an-

thers upon their filaments is either perpendicular or incumbent. Some of the latter kind are versatile, being suspended by a fine thread which admits of their being turned round a great number of times without coming off. This may be seen to great advantage in the passion-flower, as likewise in the different species of lily. The cells of the anther are destined to contain the pollen, or dust. This appears to the naked eye like a fine powder; but when examined under the microscope it is often found to have a very peculiar structure in different plants. It is discharged chiefly in dry sunny weather, when either the coats of the anther by bursting scatter it abroad, which is often assisted by some elasticity of the filaments or other parts of the flower; or else it adheres to the rough bodies of insects, as they frequent the flowers in search of honey. Each grain of the pollen remains entire so long as it continues dry, being a membranous bag, so constructed as to burst when it meets with moisture, discharging a fine elastic vapour, and this last is the effective part of the pollen. This is the general appearance of the substance we are describing; but in the orchis family, the mirabilis, the asclepias, and some of its allies, the pollen is remarkably different, consisting of glutinous, naked masses, sheathed indeed, or concealed by the peculiar structure of the flowers; but scarcely, except in the mirabilis, lodged in a proper anther. The stamens are subject to be obliterated when the plant increases much by root; they are metamorphosed into petals in what are called double-flowers, as the anemone and ranunculus, so much admired by curious florists.

4. *Pistilla*, the pistils, fig. 39, are also an essential part of a flower, standing within the circle formed by the stamens in the very centre of it; at least, they are usually in the same flower with the stamens. Sometimes they are placed in a different individual of the same species. Such are termed separated flowers. That furnished with stamens being called the male or barren blossom; that with pistils the female or fertile one. Such as have both organs in the same individual have received the appellation of united or perfect flowers, and here it may not be amiss to mention that a flower furnished with both calyx and corolla is, in Linnæan language, said to be complete; when the corolla is wanting, incomplete; and when the corolla is present without the calyx, naked. When barren and fertile flowers are borne by the same individual plant, such are named monoecious, as residing in the same house. If on the other hand they grow from two separate roots they are dioecious. Some plants besides these different kinds of flowers, bear others in which the organs are associated. To these the term polygamous has been applied. Each pistil consists of three parts, the germen, or rudiments of the future fruit or seed, which is of course essential; the style, which is not universal; and the stigma which is necessarily so, being the part destined to receive the pollen, and being furnished with its own appropriate moisture to make that substance explode. By this means the seeds within the germen are rendered fertile. In some plants the stigma has been observed to be irritable, and in others to gape for the reception of the pollen. In general it remains vigorous no longer than till the pollen has had access to it. It is necessary for botanical purposes to observe whether the germen be superior, that is, above the calyx and corolla; or inferior, below their insertion. Pistils as well as stamens are occasionally obliterated or changed to petals.

5. *Pericarpium*, the seed-vessel, for which some recent cryptogamic botanists have contrived a new term, *sporangium*, precisely of the same meaning, and altogether superfluous. The seed-vessel is formed of the germen enlarged, and is not an essential part; for many plants have naked seeds, guarded only by the permanent parts of the flower. The wisdom of nature is very conspicuous in the contrivance of seed-vessels in general; some, which remain closed while they are moist, split open with elastic force when ripe and dry; others serve for the food of animals, by whose means their seeds are transported to a distance; others make their way into the ground, by some peculiar apparatus, near the spot where they are produced; while others are wafted by the winds or transported by the waters to far distant situations. The following are the different kinds of seed-vessels:—1. *Capsula*, a capsule, fig. 40, is dry and woody, coriaceous or membranous, of one or more cells, opening and discharging its contents by valves or by pores. 2. *Siliqua*, a pod, fig. 41, is a long dry, solitary, seed-vessel, of two valves, and divided into two cells by a linear partition, along each of whose edges the seeds are ranged; of this the wall-flower and stock are examples. *Silicula*, a pouch, is a small round pod. 3. *Legumen*, a legume, fig. 42, is the

BOTANY.

Cooper sculp

14 Frond Fern Bearing Seed on the Back. 15 Stipe, Fern. 16 Simple leaf, Convolvulus. 16 + Lob'd leaf, Passion Flower. 17 Pinnate leaf, Rose. 20 Thorns Hippophæ rhamnoides. 21 Prickle, Rose. 24 Hair, Nettle. 25 Whorl, Dead Nettle. 26 Cluster, Bunch Currants. 27 Spike, Orchis. 28 Corymb, Spiræa Opulifolia. 29 Fascicle, Sweet William. 30 Head or Tuft, Thrift. 31 Umbel Hemlock. 32 Cyme, Laurustinus.

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fruit of the pea kind, solitary, formed of two oblong valves, without any longitudinal partition, and having the seeds ranged along one of its margins only. 4. *Drupa*, fig. 43, a stone-fruit, like the peach and cherry, has a fleshy undivided coat, containing a single hard stone or nut. 5. *Pomum*, fig. 44, an apple, contains a capsule of several cells in a fleshy coat. 6. *Bacca*, fig. 45, a berry, is fleshy, without valves, containing one or more seeds lodged in pulp, as the gooseberry and currant. Some berries are compound, as the raspberry; others are of a spurious kind, the pulp originating from some part not properly belonging to the fruit, as the calyx in the mulberry, and the receptacle in the strawberry. And, fig. 46, *Strobilus*, a cone, originates from a catkin, become hardened, and enlarged into a compound seed-vessel, as in the fir, birch, &c.

6. *Semina*, the seeds, fig. 47, the most essential of all the organs of fructification, being those to which all the others are subservient. The seeds are composed of several parts, the most important of which is the *embryo*, or germ. Linnæus calls it *corculum*, a little heart, in allusion to its shape in the walnut, in which, as well as in the bean, and other leguminous plants, it is readily observed. Its position is either upright, horizontal, or reversed. It is generally lodged within the substance of the seed, except in grasses. *Cotyledones*, the cotyledons, or seed-lobes, are intimately connected with the embryo: they are almost universally two in number, though in the fir tribe they are more numerous. When the seed has sent its root into the ground, these organs generally rise above the surface, and perform the functions of leaves till the proper foliage is produced. Plants, therefore, for the most part are properly denominated *dicotyledones*. Such as are called *monocotyledones* have really no proper cotyledon, and the first part that appears above the ground from their seed is a real leaf. *Albumen*, the white, makes up the chief bulk of some seeds; but never rises out of the ground, nor assumes the office of leaves, being destined solely to nourish the embryo till its roots can perform their office. It may be observed in grasses, corn, and palm-trees: in some it is farinaceous; in others as hard as a stone, witness the date. The nutritious matter, which in these plants constitutes the albumen, is in others lodged in the substance of the cotyledons. *Vitellus*, the yolk, was first named by Gærtner, and is supposed by him to furnish nourishment to the embryo. Dr. Smith, however, has first suggested that the *vitellus* is rather a subterraneous cotyledon, see his "Introduction to Botany," 292. *Testa*, the skin, a single or double membrane envelops the parts hitherto described, bursting irregularly when its contents swell in germination. *Hilum*, the scar, is the point of attachment through which nourishment is conveyed to the seed while growing. This point is always considered as the base of the seed in description.

Seeds are often accompanied by appendages or accessory parts, as *pellicula*, the pellicle, which adheres to their outside in the form of a fine skin, sometimes downy, sometimes of a mucilaginous substance. An instance of the latter occurs in Salvia verbenaca, whose seeds are celebrated for extracting particles of dust from the eye, by enveloping them in its mucilage, which swells on the application of moisture. *Arillus*, the tunic, is a complete or partial covering of a seed, fixed to its base only, and more or less closely enfolding its other parts. In the euonymus it is pulpy and orange-coloured, the seed itself being crimson. The mace which enfolds the nutmeg is of this nature. Many of the orchis tribe are enveloped in a membranous tunic, extending beyond the outline of the seeds, and giving them a light chaffy appearance. The elegant wood-sorrel has an elastic arillus, like a little bag, serving to project the seeds to a distance. In the carex the same part is in some degree inflated and membranous. The covering of the seeds in the cynoglossum is considered by Dr. Smith as a *testa* rather than an arillus. *Pappus*, the seed-down, in its most strict sense, is the chaffy, feathery, or bristly crown of several seeds that have no seed-vessel, as in the dandelion, thistle, scabious, and others. In a more general sense pappus is applied to any feathery or downy appendage to seeds, even though lodged in a pericarpium. *Cauda*, a tail, is an elongated appendage, originating from the permanent style. It is generally feathery, as in the virgin's bower, clematis. *Rostrum*, a beak, has a similar origin, but usually belongs to a seed-vessel. *Ala*, a wing, is a dilated membranous appendage, serving to waft seeds along in the air. To all the above may be added various spines, hooks, scales, and crests, generally serving to attach such seeds as are furnished with them to the rough coats of animals, and so to promote their dispersion. This appears to be the final purpose of the awns of grasses in general.

7. *Receptaculum*, fig. 48, the receptacle, is the common base or point of connection of the parts of fructification. It is essential, inasmuch as it must exist in some form or other. This part, however, comes chiefly into notice when it assumes any peculiar form, as in compound flowers; the dandelion, daisy, and thistle, for instance. In some of this class it is naked, scaly, hairy, or cellular, and such circumstances afford excellent generic characters. Such of the natural order of Proteaceæ as have aggregate flowers are also furnished with as conspicuous a receptacle as the compound flowers. The receptacle of the seeds is a term used for the part to which they are attached in a seed-vessel.

OF THE CLASSIFICATION OF PLANTS.

The species of plants, as well as of all other natural productions, are so immensely numerous, that the most superficial observer must be aware of the necessity of some regular mode of arranging them, as well as of naming and distinguishing them, in order to acquire or to retain any clear knowledge of their natures, differences, or comparative uses. Hence the distribution of plants into trees, shrubs, and herbs, into eatable, medicinal, or hurtful kinds, was very early conceived; for the human mind is naturally prone to method and combination. When the subject came to be scientifically studied, various plans were formed, as different in ingenuity and utility as possible, proceeding on various principles, but all aiming at the same end, the commodious arrangement of plants. The authors of these various schemes seem all, as far as they considered the matter with any such view, to have thought their own plan most consonant with that natural classification which every one at first sight perceived to exist in the creation; but a little experience proved that the clue of nature soon eluded their grasp.

Linnæus, the first person who took a very comprehensive and philosophical view of the laws of system, and at the same time carried them most happily into effect, for the purposes of utility and facility, was the first to perceive the difference between a natural arrangement and an artificial one. He ever considered the former as the great desideratum of philosophical botany, and indeed as necessary to be kept in view by all who describe or define new discovered plants; while the latter was to be adopted for ready use and convenience, just as words are arranged in a dictionary according to their spelling, without any regard to their derivations or analogical meanings. The same great naturalist was also, from the first, aware of the essential importance of the principle laid down by Gesner and Cæsalpinus, as we have already stated, that plants ought to be arranged by their parts of fructification alone, and not by their general habit or structure independent thereof. Hence he denominates heterodox all such systematics as class vegetables by their leaves, roots, uses, times of flowering, or places of growth, for, strange to tell! there have been such; and he esteems truly orthodox those botanists only who derive the characters of their systems from the flower and fruit, in which, as he expresses it, the true form or essence of their being is displayed. On this point all botanists are now agreed, but they differ widely concerning the eligibility of a natural or an artificial system for daily use, as well as the principles upon which each ought to be founded.

The earlier systematics began with the consideration of the seed and seed-vessel, forming their classes upon the situation of the embryo, whether at the top or base of the seed, and the number of the seeds and seed-vessels, or their cells, in different plants. Some, as the great English naturalist Ray, took into consideration, over and above the fruit and its parts, the form and number of the parts of the corolla, and even the leaves and roots, which altogether make but a motley jumble of principles; but in a second attempt this learned man was more uniform and successful in his scheme. Others founded their systems on the corolla alone, as Rivinus and Tournefort, whose methods are elegant and attractive at first sight, but far more unphilosophical, far more difficult in practice, than those founded on the fruit. The authors of these various systems disputed with great warmth concerning their respective merits, and each had his followers and advocates. Many other methods were contrived, partaking, more or less, of the principles of the few great leading systematics who contended for the botanical sceptre, and frequently borrowing from them without due acknowledgment. All these systems have now passed away, at least with respect to practical use. They are the study of the botanical antiquary, and they are instructive to the student of philosophical arrangement in general; but no work that treats of plants is arranged

by their laws, nor does any practical botanist waste his thoughts or judgment in comparing their different merits.

Two systems at the present day divide the botanical world between them, the artificial one of Linnæus, and the natural one of Jussieu. Yet it can be only those who are very unphilosophical or ignorant of the subject, or who have some sinister purpose to serve, who bring these systems into competition as rivals. They are in fact allies and mutual supports, and it is the opinion of an experienced botanist (Dr. Smith) of the present day, that in the actual state of the science perhaps neither of these systems can stand alone. Plants are so numerous, and those of their parts upon which all systems depend so liable to variations and irregularities, that neither the Linnæan system, nor any other artificial one, however simple and comprehensive its principles, can conform to them all with sufficient precision to be in any degree infallible. On the other hand, every natural system is necessarily so incomplete, for want of an uniformly perfect knowledge in its contriver of all the plants in the world, and of their mutual dependencies on each other, as well as of the best possible manner of defining and characterizing the classes and orders in which human contrivance is obliged to dispose them, that to use such a system for the investigation of plants, is like learning to read by the Chinese character. But if we use these two methods in conjunction, they eminently assist each other. If a new plant cannot be made out but by artificial marks, its affinity may be guessed at in the natural system. We shall now proceed to give an outline of both systems, that the student may understand their principles, and comprehend their several advantages.

The Linnæan system is founded on the number, situation, and proportion of the essential organs of impregnation termed stamens and pistils, whose uses and structure we have sufficiently explained. The classes, which are 24, principally owe their distinctions to the stamens; the orders, or subdivisions of the classes, are generally marked by the number of the pistils, or by some other circumstances equally intelligible. The names of both are of Greek derivation, and allude to the functions of the respective organs. The first eleven classes are distinguished solely by the number of the stamens.

I. *Monandria.* Stamen 1. From μονος one, and ανηρ a man. A small class, consisting of only 2 orders.

1. Monogynia. Style 1. From μονη one, and γυνη a woman. Instances of this are Canna, Alpinia, Lopezia, Hippuris.

2. Digynia. Styles 2. δις two, and γυνη. Corispermum, Blitum.

II. *Diandria.* Stamens 2.

1. Monogynia. Jasminum, Salvia, Veronica.

2. Digynia. Anthoxanthum only, a kind of grass.

3. Trigynia. Piper only, or pepper.

III. *Triandria.* Stamens 3.

1. Monogynia. Valeriana, Iris, Cyperus, Scirpus.

2. Digynia. Contains almost all the natural order of true grasses.

3. Trigynia. Holosteum, Montia, Polycarpon.

IV. *Tetrandria.* Stamens 4.

1. Monogynia. Protea, Scabiosa, Plantago, Galium.

2. Digynia. Buffonia.

3. Tetragynia. Potamogeton, Ruppia.

V. *Pentandria.* Stamens 5. One of the largest classes.

1. Monagynia. Borago, Echium, Primula, and some genera removed hither from the 19th class, to be mentioned hereafter, as Viola, Jasione, &c.

2. Digynia. Chenopodium, Ulmus, Gentiana. Then follow the whole natural order of Umbelliferæ, of which Daucus, Angelica, Cicuta, and Apium, are examples.

3. Trigynia. Viburnum, Sambucus.

4. Tetragynia. Parnassia.

5. Pentagynia. Statice and Linum.

6. Polygynia. Myosurus only.

VI. *Hexandria.* Stamens 6.

1. Monogynia. Lilium, and others of its natural order, thence called Liliaceous: a tribe considered by Linnæus as the nobles of the vegetable kingdom; an idea supposed to allude not merely to their beauty and splendour, but also the text, "Consider the lilies of the field how they grow, they toil not, neither do they spin."

2. Digynia. Oryza and Gahnia, grasses with 6 stamens.

3. Trigynia. Rumex, Colchicum, Scheuchzeria, the latter lately discovered to be a British genus, by the Rev. Mr. Dalton, of Yorkshire.

4. Tetragynia. Petiveria only.

5. Hexagynia. Wendlandia and Damasonium of Schreber.

6. Polygynia. Alisma only.

VII. *Heptandria.* Stamens 7.

1. Monogynia, Trientalis, and Æsculus.

2. Digynia. Limeum.

3. Tetragynia. Saururus.

4. Heptagynia. Septas.

VIII. *Octandria.* Stamens 8.

1. Monogynia. A large and beautiful order, containing Epilobium, Fuchsia, Vaccium, and the vast genus Erica; also, according to Dr. Smith, Acer.

2. Digynia. Mæhringia, &c.

3. Trigynia. Polygonum, &c.

4. Tetragynia. Adoxa, Paris.

IX. *Enneandria.* Stamens 9.

1. Monogynia. Laurus, famous for producing the cinnamon, sassafras, and camphor.

2. Trigynea. Rheum, the rhubarb only.

3. Hexagynia. Butomus.

X. *Decandria.* Stamens 10. A rather numerous class.

1. Monogynia. Cassia, and some other papilionaceous plants. Also Ruta and its family, followed by Kalmia, Rhododendron, Andromeda, &c.

2. Digynia. Saxifraga, Dianthus, Saponaria.

3. Trigynia. Silene and Arenaria, both allied to Dianthus; also Malpighia and Bannisteria.

4. Pentagynia. Lychnis, Cerastium, and Spergula; allied also to Dianthus. Cotyledon, Sedum, and Oxalis follow.

5. Decagynia. Neurada and Phytolacca.

XI. *Dodecandria.* Stamens 12—19.

1. Monogynia. Lythrum, Halesiæ, Peganum.

2. Digynia. Agrimonia.

3. Trigynia. Reseda and Euphorbia.

4. Tetragynia. Has been recently established to receive Calligonum and Apousgeton.

5. Pentagynia. Glinus.

6. Dodecagynia. Sempervivum, the houseleek.

Thus far the Linnæan classes are founded solely upon the number of the stamens. In the following ones insertion, proportion, and connection of the same parts are to be considered. Of all the preceding classes the characters of the 4th, 6th, and 10th, chiefly interfere with any of the subsequent ones, as will be explained hereafter.

XII. *Icosandria.* Stamens twenty or more, inserted into or growing out of the calyx. This mode of insertion always indicates an eatable and wholesome fruit.

1. Monogynia. Myrtus, Amygdalus, Prunus.

2. Pentagynia. According to Dr. Smith should comprise also the Digynia and Trigynia of Linnæus, as they all vary one into the other. Pyrus, Mespilus, Spinæa, and Mesambryanthemum.

3. Polygynia. Rosa, and its beautiful natural order, including Rubus, Fragaria, &c.

XIII. *Polyandria.* Stamens numerous, inserted into the receptacle. This class is very distinct in character and qualities from the last. Its plants are often poisonous.

1. Monogynia. A fine order. Capparis, Papaver, Nymphæa, Cistus.

2. Pentagynia. Dr. Smith recommends in his "Introduction to Botany," the same plan in this class as in the preceding, of uniting Digynia, Trigynia, Tetragynia, and Hexagynia of Linnæus, under Pentagynia, because as they stand now in his works, natural genera as well as the species of one genus are often separated, and several plants vary from one Linnæan order to another. Examples are, Pæonia, Delphinium, Aquilegia, Nigella, Stratiotes. Some Nigellæ have ten styles.

3. Polygynia. Dillenia, Magnolia, Anemone. Clematis, Ranunculus, &c.

XIV. *Didynamia.* Stamens two long and two short.

This class therefore is distinguished from the 4th by the proportion of its filaments, a circumstance which is only an index to other characters in the flower, for there is a correspondent irregularity in the form of the corolla. The class in question is almost perfectly a natural one, containing the Labiate, Ringens, or Personate flowers in general. The orders are as natural as the class, being only two, and founded on the structure of the fruit.

1. *Gymnospermia.* Seeds naked in the bottom of the calyx, almost always four. The plants are aromatic and wholesome. Some of the principal genera are Teucrium, Mentha, Lavandula, Lamium, Thymus, and Melittis.

2. Angiospermia. Seeds enclosed in a seed-vessel, and generally very numerous. The plants of this order are handsome, but fœted and poisonous, quite distinct in nature from those of the former, and more akin to the Pentandria Monogynia. The genera Bignonia and Antirrhinum sometimes vary with five stamens and regular flowers. Interesting genera of this order are Pedicu-

laris, Chelone, Antirrhinum, Linnæa, Orobanche, and Acanthus.

XV. *Tetradynamia*. Stamens four long and two short. A natural class, comprising the cruciform flowers, except Cleome, which is thought to have been erroneously placed here. The orders are two, perfectly natural.

1. Siliculosa. Fruit a roundish pod or pouch, Myagrum, Draba, Lunaria, Alysum, Cochlearia, Thlaspi.

2. Siliquosa. Fruit a very long pod, Dentaria, Cardamine, Cheiranthus, Brassica, Sinapis.

XVI. *Monadelphia*. Stamens united by their filaments into one tube. This is the first class in which the connexion of those parts is taken into consideration. Number therefore being here of secondary importance, serves to discriminate the orders.

1. Triandria. Sisyrinchium, Ferraria, Tamarindus, Aphyteia.

2. Pentandria. Erodium, Hermannia.

3. Heptandria. Pelargonium only, separated from Geranium by L'Herritier, an eminent French botanist.

4. Octandria. Aitonia, named by the younger Linnæus after the late Mr. Aiton of Kew garden.

5. Decandria. Geranium.

6. Endecandria. Brownea only.

7. Dodecandria. Stamens generally fifteen. Pterospermum, Pentapetes, &c.

8. Polyandria. The finest order of the whole, contains Malva, Sida, Althæa, Lavatera, Gossypium, Hibiscus, Camellia, and others; most mucilaginous emollient plants.

XVII. *Diadelphia*. Stamens united by their filaments into two parcels, both sometimes cohering at the base. Flowers almost universally papilionaceous.

1. Pentandria. Monnieria only.

2. Hexandria. Saraca, Fumaria.

3. Octandria. Polygala.

4. Decandria. The largest and most natural order, tho sections of which require to be studied with care.

* Stamens all united. These plants are strictly monadelphous, and it is only on account of their close affinity to the rest of the order that Linnæus took the liberty of placing them here. Some of them indeed, as Lupinus and Ulex, have the tenth stamen unlike the rest, though united with them below. No confusion arises in practice from this seeming contradiction of the character of the class, because the habit of these flowers is so clear and distinct from all others. If, however, a papilionaceous plant has its ten stamens all separate and unconnected, it is necessarily to be referred to the tenth class.

** Stigma downy. Without the character of the foregoing section. Phaseolus, Dolichos, Orobus, Pisum, Lathyrus, Vicia, to which Dr. Smith has added Eroum, after separating from the latter some species erroneously referred to it. See Flora Britannica, 776.

*** Legume imperfectly divided into two cells. Always without the character of the preceding sections. Biserrula, Phaca, Astragalus, the last a very extensive and intricate genus.

**** Legume with scarcely more than one seed. Psoralia, Trifolium, the latter a very irregular genus in character, though distinct in habit, sufficiently known for its agricultural uses.

***** Legume composed of single-valved joints which are rarely solitary. Hedysarum; Hippocrepis, Coronilla, Smithia, the latter furnished with irritable leaves like the true Sensitive plant or Mimosa.

****** Legume of one cell with several seeds. Many species of Trifolium properly belong here, and have been separated by some authors under the name of Melilotus; also the valuable Indigofera, with Cytisus, Robinia, Lotus, and Medicago.

XVIII. *Polyadelphia*. Stamens united by their filaments into more than two parcels. Orders characterized by the number or insertion of their stamens. In this class Dr. Smith has made many corrections, and the orders in his Introduction to Botany stand as follows.

1. Dodecandria. Stamens, or rather anthers, from twelve to twenty or twenty-five. Their filaments unconnected with the calyx. Theobroma, the chocolate tree, Bubroma, Abroma, Monsonia, and Citrus.

2. Icosandria. Stamens numerous, their filaments inserted into the calyx, in several parcels of course, as Melaleuca, a fine aromatic genus, principally from New Holland.

3. Polyandria. Stamens very numerous, unconnected with the calyx. Hypericum is the principal genus here.

XIX. *Syngenesia*. Anthers united into a tube. Flowers compound. This is entirely a natural class, and its orders likewise are founded on natural characters.

1. Polygamia Æquales. Every one of the florets which constitute the compound flower is, in this order, perfect within itself, having perfect stamens and pistil with one seed. The florets are either ligulate, as in

the dandelion; tubular, forming a globose head, as in the thistle; or tubular, and level at the top; or discoid, as in lavender cotton, *santolina*.

2. Polygamia Superflua. Florets of the disk like the discoid, flowers of the last order, and, like them, perfect within themselves. Those of the margin furnished with pistils only, but all the florets produce perfect seed. In this order the marginal florets are sometimes minute and inconspicuous, but they are for the most part ligulate, and from diverging rays, as in the daisy, aster, chrysanthemum, &c.

3. Polygamia Frustranea. Differs from the last order only in having the florets of the margin abortive or neuter; in the former case there are no rudiments of a pistil in these florets, as in centaurea; or there are abortive pistils, as in the sun-flower. This order is considered by Dr. Smith as not essentially different from the last.

4. Polygamia necessaria. Florets of the disk furnished with perfect stamens only, those of the margin with perfect pistils only, as in the garden marigold, *calendula*.

5. Polygamia Segregata. Several flowers, either simple or compound, with united anthers, and a partial calyx, all included in one general calyx, as the globe thistle, &c.

Another order follows in Linnæus, called Monogamia, consisting of simple flowers with united anthers; but this order is now generally abolished. The circumstance of the union of the anthers in simple flowers being extremely various and uncertain, though in compound ones scarcely liable to any exception.

XX. *Gynandria*. Stamens inserted either upon the style or germen. Such is the true idea of this class, and its character thus understood is as much founded in nature and reality as that of any other; by which we do not mean, that the class is a natural one, like the 19th, as it, in fact, comprises several natural families, whose allies may happen to be in other classes. Linnæus, in his idea of this class, has understood as belonging to it, many plants whose stamens did not really grow out of the germen, as the passion-flower, the sisyrinchium, &c. Hence Thunberg, and some other botanists, have judged the class altogether untenable. In the orders some alterations have recently been made by Dr. Smith, the reasons for which are more fully particularized in his Introduction to Botany, than we have room here to explain. These orders are distinguished by the number of stamens. Monandria, the first of them, contains almost all the Orchis tribe. To the fifth, Pentandria, Dr. Smith refers many of the natural family of Contortæ, as Pergularia, Cynanchum and Asclepias, a curious tribe, the structure of whose organs of impregnation is extremely puzzling even to the botanical adept. They have hitherto been placed in the fifth class, and some have thought they should be referred to the tenth. In the 6th order of this class, Hexandria, we find the aristolochia, or birth-wort.

XXI. *Monoecia*. Stamens and pistils in separate flowers, but on the same plant.

The orders of this class are, like those of the last, distinguished by the number of the stamens, or by some other character of the foregoing classes. The most genuine examples of it are such as have a different structure in the two kinds of flowers, besides the essential difference with respect to stamens and pistils, as the oak, chesnut, hazle.

XXII. *Dioecia*. Stamens and pistils like the former in separate flowers, but on two separate plants.

The orders of this class are characterised like those of the preceding. The willow, hop, hemp, &c. belong to it.

XIII. *Polygamia*. Stamens and pistils separate in some flowers, united in others, either on one, two, or three distinct plants, Dr. Smith has first suggested that no plants should be admitted into this class without a difference in the accessory parts of their flowers, over and above what concerns the stamens and the pistils. Without such a rule the class would be overwhelmed with the trees of tropical countries.

The orders are Monoecia, when the several kinds of flowers grow on one plant, as Atriplex: Dioecia, when they are situated on two separate ones; and Trioecia, when they occupy three several individuals of the same species.

XXIV. *Cryptogamia*. Stamens and pistils either not well ascertained, or not to be numbered with certainty.

1. *Filices*, ferns, whose flowers are almost entirely unknown. The seed-vessels commonly grow on the back of the leaf, thence denominated a frond, and are either naked or covered with a membrane. In some few they form spikes or clusters of capsules.

2. *Musci*, mosses, a peculiar family of plants, possessing great elegance, though diminutive in size; extremely tenacious of life, growing in the hottest as well as the coldest climates; flourishing most in the

damp wintry months. Their herbage consists of pellucid leaves, sometimes accompanied with a stem; their capsule is of one cell and of one valve, closed with a vertical lid; seeds numerous and small; the capsule is covered with a calyptra or membranous veil, the summit of which is the stigma, a circumstance absolutely peculiar to this family; the stamens are mostly in a separate flower and numerous. The late Dr. Hedwig of Leipsic is celebrated for his discoveries relating to mosses. He has distinguished their genera by the peristomium or fringe, which in most cases surrounds the mouth of the capsule. This fringe is either single or double. In the former case it consists of either four, eight, sixteen, thirty-two, or sixty-four teeth. The inner peristomium when present is more membranous, plaited, and jagged. The principles of Hedwig have been adopted with a few requisite limitations by the most able writers in this branch of botany.

3. *Hepaticæ*, liverworts. The herbage of these plants is most generally a frond, or leaf, bearing the fructification; but they differ most essentially from the last order in the want of a lid to the capsule, which is formed quite on a different principle from that of mosses, and very various in the several genera. Jungermannia and Marchantia are examples of this order.

4. *Algæ*, flags. The herbage of these is also frondose, being sometimes a powdery crust, sometimes leathery or gelatinous; the seeds are imbedded in the frond, or in some appropriate receptacle; the stamens are scarcely known. The vast family of Lichen occurs here, the most hardy of vegetables, clothing exposed rocks, trunks of trees, and barren heaths, in the most cold and inhospitable climates. On one of them the rein-deer depends for sustenance in the winter. Others are useful in dyeing, and even medicine. The numerous and various tribe of sea-weeds, Fucus, Conferva, and Ulva, are classed here.

5. *Fungi*, mushrooms. These are fleshy in substance, of quick growth, and generally of short duration. They are divided into Angiocarpi which bear seeds internally; and Gymnocarpi, whose seeds are imbedded in an exposed membranous organ. Many of these are eatable, some poisonous. Linnæus had a great prejudice against the use of any of them as food.

Appendix. *Palmæ.* The magnificent natural order of palms was placed by Linnæus as an appendix to his system, because their parts of fructification were not well known when he first wrote. They are now, however, in general so well understood that the plants in question are easily reducible to the regular classes of the Linnæan system; and it would be advisable for any future editor to arrange them accordingly. They principally belong to the Hexandria Monogynia, and are nearly allied to many plants already referred to that class.

Palms are called by Linnæus the princes of the vegetable kingdom, and are remarkable for their lofty growth, their simple stems crowned with evergreen leaves, and their abundant fruits. Among them we find the date, so valuable an article of food for many nations; the cocoa-nut, and many other fruits of less value. Some supply whole nations with oil, for food or economical uses, from their fruits, with wine from the juices of their stem, or with cordage from its fibres.

We shall now proceed to give a sketch of the natural system of arrangement published by Jussieu, a botanist of the first eminence, now living at Paris. Its primary divisions are founded upon the structure of the seed, whence is derived the distinction of all plants into Acotyledones, destitute of a cotyledon; Monocotyledones, such as have one cotyledon; and Dicotyledones, such as have two. Under the last are included a few genera that have numerous cotyledons, as Pinus and its allies, which Jussieu considers as having two cotyledons, each divided into several segments, but erroneously. So that this last section should rather be characterized as having two or more cotyledons.

The classes of Jussieu's method are fifteen, and comprize in all an hundred orders. These classes have no appropriate names, but are distinguished by numbers with a short definition of the essential character. The orders, except those of the first class, are for the most part named after some principal genus belonging to each. It is to be observed that with respect to the cotyledons, there are some inaccuracies in the terms used, for many of the supposed Monocotyledones are now known to have no cotyledon at all, and what has been so called in the rest is more properly an albumen.

Class I. *Acotyledones.* The orders of this are in a great measure analogous to the 24th class in Linnæus. 1. *Fungi;* 2. *Algæ;* 3. *Hepaticæ;* 4. *Musci;* 5. *Filices;* to which is added a sixth, termed *Naiades,* which

contains several water plants, as Hippuris, Myriophyllum, Potamogeton, Lemma, &c. Along with which Jussieu reckons several genera of the structure of whose seed, and consequently of the primary character of whose class he was uncertain.

Class II. *Monocotyledones* with the stamens inserted beneath the germen, or in Linnæan language, having the germen superior.

The orders are four, 7. *Aroïdeæ;* as Arum, &c. 8. *Typhæ*, consisting of Typha and Sparganium; 9. *Cyperoideæ*, as Carex, Scirpus, Cyperus, &c. and 10. *Gramineæ*, the true grasses.

Class III. *Monocotyledones* with the stamens inserted round the pistil, this is upon the calyx or corolla.

The orders are eight, 11. Palmæ, of which we have spoken at the end of the Linnæan system; 12. *Asparagi*, Asparagus, Convallaria, &c.; 13. *Junci*, Juncus, &c. to which are added Commelina, Butomus, Sagittaria, Veratrum, and even Colchicum. 14. *Lilia*, as Tulipa, Fritillaria, Lilium, &c. 15. *Bromeliæ*, of which the Pine apple and Agave are instances; 16. *Asphodeli*, consisting of Aloe, Asphodelus, Hyacinthus, Ornithogalum, Allium, and several others. 17. *Narcissi*, Hemerocallis, Amaryllis, Narcissus, Galanthus, and others; 18. *Irides*, Ferraria, Iris, Ixia, Gladiolus, Crocus exemplify this order.

Class IV. *Monocotyledones* with the stamens inserted upon the germen or style, that is, having the germen inferior.

The orders are four, 19. *Musæ*, including the Plantain-tree and Heliconia; 20. *Cannæ*, which are the Scitamineæ of Linnæus and other writers, and which have been lately so ably illustrated by Mr. Roscoe, in the 8th volume of the Linnæan Society's Transactions; 21. *Orchideæ*, a beautiful and favourite tribe; 22. *Hydrocharides*, a rather obscure order, under which Jussieu enumerates Vallisneria, Stratiotes, Hydrocharis, and some others which are very doubtful, or rather certainly misplaced here.

Class V. *Dicotyledones* without petals, stamens as in the last class.

Order only one, 23 *Aristolochiæ*, consisting of Aristolochia, Asarum, and Cytinus, in the first of which Jussieu takes for a calyx what other botanists esteem a corolla.

Class VI. *Dicotyledones* without petals, stamens inserted into the calyx.

The orders are six, 24. Elæagni, as Hippophae, Elæagnus, Thesium, &c.; 25. *Thymeleæ*, which comprises Daphne, Passerina, and their allies; 26. *Proteæ*, consisting of the great Cape family Protea, Banksia, Embothrium, &c.; 27. *Lauri*, as Laurus, and some other genera supposed to be allied to it; 28. *Polygoneæ*, composed of Polygonum, Rumex, Rheum, &c.; 29. *Atriplices*, Chenopodium, Atriplex, and others.

Class VII. *Dicotyledones*, without petals, stamens inferior to the germen.

The orders are four, 30 *Amaranthi*, Amaranthus, Celosia, Gomphrena, Herniaria, &c.; 31. *Plantagines*, Psilium, Plantago, and Littorella; 32. *Nyctagines*, Mirabilis, Boerhaavia, &c.; 33. *Plumbagines*, Plumbago, and Statice.

Class VIII. *Dicotyledones*, of one petal, which is inserted under the germen.

The orders are fifteen, 34. *Lysimachiæ*, Anagallis, Primula, &c. with some doubtful ones; 35. *Pediculares*, Veronica, Euphrasia, Pedicularis, &c.; 36. *Acanthi*, Acanthus, Ruellia, Justicia; 37. *Jasmineæ*, Syringa, Fraxinus, olea, Jasminum; 38. *Vitices*, a numerous order, Clerodendrum, Volkameria, Vitex, Verbena, &c.; 39. *Labiatæ*, a large order containing the Didynamia Gymnospermia of Linnæus, with some few from his Diandria, as Salvia, &c.; 40. *Scrophulariæ*, consists chiefly of the Didynamia Angiospermia of Linnæus; 41. *Solaneæ*, Verbascum, Hyocsyamus, Atropa, Solanum, with some other plants of the Linnæan 5th class, and a few of the Didynamia compose this order; 42. *Borragineæ*, contains the Asperifoliæ, as Borago, Anchuso, Echium, &c. with Cordia, Varronia, Hydrophyllum, and some others; 43. *Convolvuli*, Convolvulus, Ipomæa, Evolvulus, and some doubtful genera; 44. *Polemonia*, Phlox, Polemonium, &c. with Ipomopsis of Michaux and Smith; 45. *Bignoniæ*, Chelone, Bignonia, Martynia, and a few others; 46. *Gentianæ*, consists of some remarkably bitter plants, Gentiana, Swertia, Chlora, Lisianthus, Chironia; 47. *Apocinæ*, the Contortæ of Linnæus, some of which belong to his Pentandria, as Vinca, Nerium, Apocynum, &c. and others have been referred by Dr. Smith to Gynandria, as Pergularia, Cynanchum, and Asclepias; 48. *Sapotæ*, Achras, Chrysophyllum, Jacquinia, and others.

Class IX. *Dicotyledones*, of one petal, inserted into the calyx.

Orders four, 49. *Guaïacanæ*, consisting of Diospyros, Styrax, Halesia, Symplocos, &c.; 50. Rhododendra, as Kalmia, Rhododendrum, Azalea; also Rhodora, Ledum, Bejaria, and Itea, which four last but ill accord with the character of the class, being really polypetalous; 51. *Ericæ*, as

the vast genus Erica, also Andromeda, Arbutus, Pyrola, Clethra, Vaccinium, and others, several of which are likewise polypetalous; 52. *Campanulaceæ*, some of these have distinct anthers, as Campanula, Trachelium, Roella, Scœvola, Phyteuma; others have the same parts cohering, as Lobelia and Jasione. To this order belong Dr. Smith's Goodenia and Stylidium, see his Introduction to Botany, 464.

Class X. *Dicotyledones*, of one petal, crowning the germen. Anthers united into a tube. Flowers compound. Orders three.

This class comprises the Syngenesia of Linnæus, except his last order Monogamia, which, as we have already mentioned, is now laid aside. 53. *Cichoraceæ*, consists of such of Linnæus's order of Polygamia Æqualis as have ligulate florets, as Sonchus, Hieracium, Leontodon, Tragopogon, Catananche, &c.; 54. *Cinarocephalæ*, the Thistle tribe, Carthamus, Carlina, Cinara, Carduus, Centaurea, of which last Jussieu makes several genera; 55. *Corymbiferæ*, is a large order containing the rest of the Linnæan Syngenesia, most of which are radiated flowers except the first section. Examples of this order are Eupatorium, Gnaphalium, Conyza, Senecio, Calendula, Chrysanthemum, Artemisia, Anthenis, Bidens, Helianthus, Arctotis, besides some very anomalous ones with separated flowers, whose anthers are scarcely connected, as Ambrosia, Xanthium, &c.

Class XI. *Dicotyledones*, of one petal, crowning the germen. Anthers distinct.

Orders three, 56. *Dipsaceæ*, the flowers of which are generally aggregate, as Dipsacus, and Scabiosa; Valeriana has simple flowers; 57. *Rubiaceæ*, a vast order, is exemplified by Galium, Rubia, Hedyotis, Cinchona, Gardenia, Ixora, Coffea; 58. *Caprifolia*, as Linnæa, Lonicera, Sambucus, Cornus, Hedera.

Class XII. *Dicotyledones*, with several petals, stamens inserted upon the germen.

Orders two, 59. *Araliæ*, a small order, the fruit pulpy or capsular, contains chiefly Aralia, Cussonia, and Panex; 60. *Umbelliferæ*, a very large and natural order, sufficiently well known to those who have at all considered plants, though not a favourite tribe with botanists in general. Some of the chief genera are Thapsia, Scandix, Angelica, Heracleum, Athamanta, Daucus, Caucalis, and Bupleurum.

Class XIII. *Dicotyledones*, with several petals, stamens inserted under the germen.

Orders twenty-two, 61. *Ranunculaceæ*, the acrid tribe of Clematis, Thalictrum, Anemone, Ranunculus, Helleborus, Aconitum, Pœonia, Actæa; 62. *Papaveraceæ*, consists of Papaver Chelidonium, and their allies; 63. *Cruciferæ*, the great natural order of cruciform plants, constituting the Linnæan Tetradynamia, as Brassica, Cheiranthus, Alyssum, Thlaspi; 64. *Capparides*, Cleome, Capparis, &c. to which are subjoined as akin to them Reseda, Drosera, Parnassia; 65. *Sapindi*, Sapindus, Paullinia; 66. *Acera*, Asculus, Acer, &c.; 67. *Malpighiæ*, Bannisteria, Malpighia, and a few others. These three last orders are somewhat obscurely defined; 68. *Hyperica*, consists of Ascyrum Brathys, and Hypericum; 69. *Guttiferæ*, an original order of Jussieu's, and a very natural one, contains Gambogia, Clusia, Garcinia, Mammea, Calophyllum, and some others; 70. *Aurantia*, Citrus, Limonia, Murræa, genera remarkable for the pellucid spots in their leaves properly exemplify this order, to which are added among others Thea and Camellia; 71. *Meliæ*, a very natural order, of which the tubular nectarium bearing the stamens is the principal character, as Turræa Aitonia, Trichilia, Melia, Swietenia, and Cedrela, the two last are kinds of mahogany; 72. *Vites*, consists only of Cissus and Vitis; 73. *Gerania*, consists of Geranium (including Pelargonium and Irodium of L'Heritier) and Monsonia, to which are subjoined as akin to them Tropeolum, Impatiens, and Oxalis; 74. *Malvaceæ*, Malva, Lavatera, Hibiscus, and others constituting the Monadelphia class of Linnæus, with some others related thereto; 75. *Magnoliæ*, composed of Magnolia, Liriodendrum, Micheliæ, with some others; 76. *Anonæ*, nearly allied to the last, as Anona, Unona, Uvaria, and Hilopia; 77. *Menisperma*, Cissampelos, Menispermum, &c.; 78. *Barberides*, Berberis, Leontice, Epimedium with some supposed to be allied to them; 79. *Tiliaceæ*, Hermannia, Sparmannia, Grewia, Tilia, &c.; 80. *Cisti*, Cistus is the chief and most certain of these, from which genus Jussieu separates Helianthemum; 81. *Rutaceæ*, Tribulus, Zygophyllum, Ruta, Dictamnus, and others, many new genera of this order have been discovered in New Holland: see Tracts Relating to Natural History, by Dr. Smith, who considers Oxalis as belonging here; 82. *Caryophyleæ*, the Pink and Campion tribe, which is very natural, as Spergula, Arenaria, Dianthus, Silene, &c.

Class XIV. *Dicotyledones*, with several petals, stamens inserted into the calyx or corolla.

Orders thirteen, 83. *Sempervivæ*, a suc-

culent tribe, Cotyledon, Sedum, Sempervivum; 84. *Saxifragæ*, Saxifraga, Chrysosplenium, &c. among which Hydrangea must surely rather belong to the *Caprifolia;* 85. *Cacti*, consists of Ribes and Cactus, a paradoxical association; 86. *Portulaceæ*, Portulaca, Tamarix, Claytonia, &c. the last mentioned genus is suspected to be monocotyledonous; 87. *Ficoideæ*, of which the most remarkable is the vast genus Mesembryanthemum; 88. *Onagræ*, Ænothera, Epilobium, and Jussiæa exemplify this, and the beautiful Fuchsia, with others, are subjoined, some of which belong to the following order; 89. *Myrti*, a fine and very natural family, composed of Melaleuca, Septospermum, Eucalyptus, Myrtus, Eugenia, &c; 90. *Melastomæ*, as Melastoma, Osbeckia, Rhexia, all remarkable for handsome anthers; 91. *Salicariæ*, Lythrum, Lawsonia, Peplis, Glaux, &c.; 92. *Rosaceæ*, a very large and fine order, constituting in general the Icosandria of Linnæus; as Pyrus, Rosa, Fragaria, Rubus, Prunus, with many more; 93. *Leguminosæ*, a still more extensive order than the preceding, in which the system under our consideration, as keeping so natural an order entire, has much the advantage of the Linnæan artificial system, which, being founded only on the stamens, unavoidably disunites it. To this are referred Mimosa, Tamarindus, Cassia, Poinciana, Bauhinia, Sophora, Genista, Lupinus, Trifolium, Phaseolus, Astragalus, Vicia, Hedysarum, Pterocarpus, and many other genera related to each of the above; 94. *Terebintaceæ*, a rather confused order; in it we find Rhus, Canarium, Schinus, Pistacia, Zanthoxylum, and even Juglans, is put here on account of a slight affinity; 95. *Rhamni*, is a more satisfactory order; as Euonymus, Celastrus, Cassine, Ilex, Rhamnus, &c.

Class XV. *Dicotyledones*, with stamens in separate flowers, from the pistils.

Orders five. 96. *Euphorbiæ*, consists of Mercurialis, Euphorbia, Phyllanthus, Buxus, Croton, Hippomane, with several more, for the most part acrid, and often milky plants; 97. *Cucurbitaceæ*, the gourd tribe, Bryonia, Cucumis, Passiflora, with a few more; 98. *Urticæ*, composed of Ficus, Morus, Urtica, Humulus, Cannabis, to which, among others, Piper is subjoined as an ally; 99. *Amentaceæ*, Salix, Populus, Betula, Quercus, Corylus, &c. to which Ulmus, Celtis, and Fothergilla are prefixed; 100. *Coniferæ*, Casuarina, Juniperus, Cupressus, are examples of this very distinct order.

At the end of this system is a large assemblage of genera, under the denomination of *Plantæ incertæ sedis*, as not capable of being referred to any of the foregoing orders. Some of them, perhaps, when better known, may be removed into the body of the system, but many must always remain in doubt. Nor is this to be esteemed as a fault peculiar to the system of Jussieu. It must be the case with all natural systems, unless it were possible for their contrivers to have all the genera of plants from every corner of the earth before them at one view.

As long as any remain to be discovered, or any that are discovered are imperfectly known, every such system must be defective. Besides, it appears that plants are connected, not in one regular series, but, as it were, in a circle, touching or approaching each other by so many different points, that no human sagacity can detect which points of connection are most important, so as to obtain an infallible clue through so vast a labyrinth.

A natural system of botanical arrangement being therefore probably unattainable in perfection, we are obliged to be content, for daily use, with an artificial one. When we meet with an unknown plant, we count its stamens and styles, or observe any other circumstance attending those organs, on which the characters of the Linnæan classes are founded. Having easily determined the class of our plant, we in like manner ascertain its order. We proceed to compare the parts of its flower and fruit with the characters of every genus in that order, till we find one that agrees with them. Having fixed the genus, we in like manner read over the characters of the species, in case the genus consists of more than one, till we are satisfied we have met with the right. Thus we learn the generic and specific name of our plant, and are enabled to find any thing recorded concerning it.

Such is the mode of applying the Linneæan system to use, and in ordinary cases no difficulties attend it. But it may happen that we have found a plant whose number of stamens is variable in itself, or perhaps different from their usual number in the natural genus to which it belongs; for all genera ought to be natural, and no species must be divided from its brethren on account of characters which only respect the artificial classes and orders. In this case Linnæus has provided us a remedy, by enumerating at the head of each class all

such anomalous species, as far as he could recollect or determine them; so that if our plant does not agree with any of the regular genera of the class, we may seek it among these irregular species. If, after all our attempts, the plant under consideration still proves refractory, the system of Jussieu comes to our aid. Not that we can hope, even though adepts in the science, to determine a plant by the same mode in this author; beginning with the cotyledons, which, in many cases, we shall find it impossible to judge of, and which, when found, will often lead us astray in the more abstruse orders of Jussieu.

The true way to use this system is to consider what known genus or family our plant most approaches in its habit and leading characters. By turning to such, through the help of the index, and reading the characters of the corresponding order, we shall be able to judge how far we are right, and shall, at any rate, grow familiar with natural orders and affinities. When we have determined the genus of our plant in Jussieu, as he has not treated of species, we must still recur to Linnæus for that part of the subject, as well as for synonyms of other authors, and references to figures or descriptions.

By such a manner of associating these two great authors, we render them truly serviceable to each other, and to the science; whereas, by placing them in opposition, we only make stumbling-blocks of all their defects; for there must be defects in all attempts of the human intellect to keep pace with the infinite wisdom and variety displayed in the works of God.

With respect to the application of either of these methods of arrangement to medical use, as a means of forming any probable judgment of the qualities of plants; the more natural any system is, the better it serves us in this particular. But even the Linnæan classes and orders are many of them sufficient for general use, and their learned author has occasionally suggested other remarks, peculiar to himself, tending to the same end.

His Didynamia Gymnospermia, and the ringent flowers with naked seeds, allied thereto, which, having only two stamens, are necessarily placed in his second class Diandria, are all innocent or wholesome: those of the other order, Angiospermia, are fetid, narcotic, and dangerous, being akin to a large part of Pentandria Monogynia, known to be poisonous, as containing henbane, nightshade, and tobacco. The whole class Tetradynamia is wholesome, except the fetid cleome, wrongly referred to it. Whenever the stamens are found to grow out of the calyx, whether they be numerous, as in Icosandria, or few, as in the currant and gooseberry, they infallibly indicate the pulpy fruits of such plants to be wholesome. Whenever the nectary is a distinct organ or structure from the petals, Linnæus justly observes, that the plants to which it belongs are to be suspected. The papilionaceous or pea flower is remarked by him to belong to a wholesome family, which is generally true, at least when the plants are boiled or roasted. We think it right, however, to mention one exception to the innocence of this family, as it is not generally known, The seeds of the laburnum, eaten unripe, are violently emetic and dangerous. They are, indeed, so bitter and nauseous as seldom to tempt children, but we have heard of their being eaten, and such was the consequence, which is the more important to be known, as the tree is so common.

Milky plants are generally to be suspected, except such as have compound flowers; but even some of these are highly dangerous, as the wild lettuce, Lactuca virosa, which yields a kind of opium, and the stinking hawkweed, Crepis fœtida. Crepis rubra also, or pink hawkweed, commonly cultivated for its beauty, may be in the same predicament; but it is too nauseous to be eaten. Umbelliferous plants, which grow in dry or elevated situations, are aromatic, safe, and often very wholesome; while those that inhabit low and watery places are usually among the most virulent and deadly of all poisons whatever. Oenanthe crocata poisons by its scent in a room, causing headachs, nausea, and swoonings. Cicuta virosa, if eaten by cattle unawares while under water, kills them, as Linnæus informs us, with the most horrible symptoms. The mallow tribe, or Columniferæ, so called from bearing their stamens in a columnar form, are all emollient, abounding with a mucilaginous juice, without taste and smell, very useful in internal irritations. To this probably Horace alludes when he speaks of læves malvæ, and not to any external smoothness of the plants mentioned, which by their soft and downy leaves would rather claim the epithet of molles. The liliaceous family are often very dangerous, especially their bulbous roots, from some of which the wild natives of southern Africa are said to obtain a poison

for their darts. The natural order of grasses are, as every one knows, wholesome throughout; for the intoxicating effects recorded of Lolium temulentum can hardly be deemed an exception. The beneficent Author of Nature has usually indicated the wholesome qualities of plants by an agreeable smell or taste, while dangerous ones are endued with contrary flavours. The berries of deadly nightshade, *Atropa belladonna*, are indeed an exception to this, but a rare one.

Wnen we speak here of plants as being wholesome or poisonous, it must be understood only with a reference to our own species, and those animals which most approach us in shape and constitution, as quadrupeds, and even of these some form an exception. Thus goats prefer and thrive upon the most acrid plants, which blister the stomachs or even hands of the human species, as clematis, anemone, ranunculus, &c. Insects in general feed on the most virulent herbs, which no other animals can taste, and thus such are turned to account in the general plan of nature. The art of cookery renders many vegetables wholesome to man, that without it would be far otherwise, as the potatoe, which is a species of nightshade, or Solanum, and many fruits are rendered much more salutary in consequence of being dressed. The cassava bread of the West Indies is made of the highly acrid Jatropha, purified by washing and daying. A number of further observations might be added; but the above are sufficient to shew the use of botanical science in a medical point of view. The necessity that those who make use of highly powerful plants for the cure of diseases should know one plant from another is evident. We have known the useless Lythrum salicaria gathered, and sold to the apothecary, for fox-glove, and the sweet inactive chervil for the powerful hemlock; we have also known henbane taken for clary. A little science will guard against such mistakes. The "Medical Botany" of the late Dr. Woodville, so extensive in its sale among country practitioners, has perhaps done more to prevent them than most other books; but the liberal and dignified physician should be able, by more philosophical means, not only to guard against mistakes and mischief, but by new inquiries and studies to advance the healing art.

BOTE, in our old law-books, signifies recompence or amends: thus manbote, is a compensation for a man slain. There are likewise house-bote and plough-bote, privileges to tenants of cutting wood for making ploughs, repairing tenements, and likewise for fuel.

BOTRYCHIUM, in botany, a genus of the Cryptogamia Filices class and order: capsule nearly globular, distinct, clustered in a raceme-like spike; one-celled, opening from the top to the base. There are five species.

BOTTLE, a small vessel proper for holding liquors. We say a glass bottle, a stone bottle, a leathern bottle, a wooden bottle, a sucking-bottle. Of glass bottles no mention occurs before the 15th century: for the "Amphoræ vitreæ" of Petronius, to the necks of which were affixed labels, expressing the name and age of the wine, appear to have been large jars, and to have formed part of the many uncommon articles by which the voluptuary Trimalchio wished to distinguish himself. It is, however, singular, that these convenient vessels were not thought of at an earlier period, especially as among the small funeral urns of the ancients, many are to be found, which, in shape, resemble our bottles.

Beckmann conceives that he discovers the origin of our bottles in the figure of the Syracusan wine-flasks. Charpentier cites, from a writing of the year 1387 an expression which seems to allude to one of our glass bottles; but this, attentively considered, refers merely to cups or drinking glasses. The name boutiaux, or boutilles, occurs in the French language for the first time in the 15th century; but if it were more ancient it would prove nothing, as it signified originally, and still signifies, vessels of clay or metal, and particularly of leather. Such vessels, filled with wine, which travellers were accustomed to suspend from their saddles, might be stopped with a piece of wood, or closed by means of wooden or metal tops screwed on them; and such are still used for earthen pitchers. We shall here add, that stoppers of cork must have been introduced after the invention of glass bottles. In 1553, they were little known; and their introduction into the shops of the apothecaries in Germany took place about the end of the 17th century. Before that period, they used stoppers of wax, which were more troublesome and more expensive. The ancient Jewish bottles were cags made of goats' or other wild beasts' skins, with the hair on the inside, well sewed and pitched together; an aperture in one of the animal's

33 Panicle Oat 34 Bunch Common Vine. 35 Calyx, Rose 36 Corolla, Rose 37 Nectary Monkshood 38 Stamen Lilly
39 Pistil Lilly 40 Capsule Datura 41 Siliqua, Stock 42 Legume, Pea 43 Drupa Cherry 44 Pomum, Apple
45 Bacca, Gooseberry _ 46 Strobilus, Fir _ 47 Seed, Bean laid open 48 Receptacle Daisy

Cooper sculp

London Published, Feb.y 1, 1808, by Longman, Hurst Rees & Orme, Paternoster Row

paws serving for the mouth of the vessel. Calmet.

Bottles of this kind are mentioned in scripture, and they were used for carrying water through the deserts of Arabia and other countries, where springs and streams are scarce. Such bottles, indeed, have been in common use both in ancient and modern times. The word used by Job (ch. xxxii. 19) signifies, in the original, to swell or distend; it is properly used to express a skin bottle, which would be made to swell by the liquor poured into it, and which would be more distended and enlarged, till they would at last burst, if they had no vent, by the fermentation of the liquor as it advanced towards ripeness. Hence we perceive the propriety of putting new wine into new bottles, &c. according to the appropriate allusion in the gospels, which being moist and strong, would resist the expansion, and preserve the wine to due maturity; whereas old bottles of this kind, being dry and more brittle, would be in danger of bursting, and were best adapted to receive old wine, the fermentation of which had ceased.

These leather bottles are supposed, by a sacred historian, not only to be frequently rent, when grown old and much used, but also to be capable of being repaired (Josh. ix. 4.) Modern travellers, as well as ancient authors, frequently take notice of these leathern bottles. The Arabs, says Sir John Chardin, and all those who lead a wandering life, keep their water, milk, and other liquors, in these bottles, the manner of repairing which he also describes. They serve, according to this writer, to preserve their contents more fresh than in any other way. They are made, he says, of goat-skins: when the animal is killed, they cut off its feet and its head, and in this manner they draw it out of the skin without opening the belly. They afterwards sew up the places where the legs were cut off, and the tail, and when it is filled, they tie it about the neck. These nations, and the country people of Persia, never go a journey without a small leathern bottle of water hanging by their side like a scrip. The great leathern bottles are made of the skin of an he-goat, and the small ones, that serve instead of a bottle of water on the road, are made of a kid's skin. In speaking of the Persians, the same traveller says, that they use leathern bottles, and find them useful in keeping water fresh, especially if people, when they travel, take care to moisten them, wherever they find water. The evaporation thus furnished, serves also to keep the water cool. He says, that the disagreeable taste of the leather is taken off, by causing it to imbibe rose-water when it is new, and before it is applied to use.

Formerly, it is said, the Persians perfumed these leathern vessels with mastic, or with incense. From him also we learn, that they put into these goat-skin and kid-skin vessels every thing which they want to carry to a distance in the East, whether dry or liquid; they are thus preserved fresher than if they were conveyed in boxes or pots: the ants and other insects are prevented from getting among them, and they are thus kept free from dust; and for these reasons butter, honey, cheese, and other such aliments, are inclosed in vessels made of the skins of these animals. Accordingly the things, particularly the balm and honey, which were somewhat liquid that were carried to Joseph as a present, were probably inclosed in little vessels made of kid-skins. Homer also refers to this mode of preserving various kinds of provision in leathern vessels. Glass bottles are better for cider than those of stone. Foul glass bottles are cured by rolling sand or small shot in them; musty bottles by boiling them. Bottles are chiefly made of thick coarse glass; though there are likewise bottles of boiled leather made and sold by the case-makers. Fine glass bottles, covered with straw or wicket, are called flasks. The quality of the glass has been sometimes found to affect the liquor in the bottle.

BOTTOM, in navigation, is used to denote as well the channel of rivers and harbours, as the body or hull of a ship: thus, in the former sense, we say, a gravelly bottom, clayey bottom, sandy-bottom, &c. and in the latter sense, a British bottom, a Dutch bottom, &c.

By statute, certain commodities imported in foreign bottoms, pay a duty called petty customs, over and above what they are liable to, if imported in British bottoms.

BOTTOMRY, in commerce, a marine contract for the borrowing of money upon the keel or bottom of a ship; that is to say, when the master of a ship binds the ship itself, that if the money be not paid by the time appointed, the creditor shall have the said ship.

Bottomry is also where a person lends money to a merchant, who wants it in traffic, and the lender is to be paid a greater sum at the return of the ship, standing to the hazard

of the voyage. On which account, though the interest be greater than what the law commonly allows, yet it is not usury, because the money being furnished at the lender's hazard, if the ship perishes, he shares in the loss.

BOTTONY, a cross bottony, in heraldry, terminates at each end in three buds, knots, or buttons, resembling, in some measure, the three-leaved grass.

BOTTS. See OESTRIS.

BOUCHE *of court*, the privilege of having meat and drink at court, scot-free. This privilege is sometimes only extended to bread, beer, and wine; and was anciently in use as well in the houses of noblemen as in the king's court.

BOUGUER (PETER), in biography, a celebrated French mathematician, born at Croisci in, Lower Bretagne, in February, 1698. His father, John, was professor of hydrography, and author of "A Complete Treatise on Navigation." Young Bouguer learnt mathematics of his father, from the time he was able to speak, and thus became a proficient in those sciences while he was yet a child. He was sent very early to the Jesuits' college at Vannes, where he had the honour to instruct his regent in the mathematics, at eleven years of age. Two years after this he had a public contest with a professor of mathematics, upon a proposition which the latter had advanced erroneously; and he triumphed over him; upon which the professor, unable to bear the disgrace, left the country. Upon the death of his father, he was appointed to succeed in his office of hydrographer, after a public examination of his qualifications; being then only fifteen years of age; an occupation which he discharged with great respect and dignity at that early age. In 1727, at the age of twenty-nine, he obtained the prize proposed by the Academy of Sciences, for the best way of masting of ships. This first success of Bouguer was soon after followed by two others of the same kind; he successively gained the prizes of 1729 and 1731; the former, for the best manner of observing at sea the height of the stars, and the latter, for the most advantageous way of observing the declination of the magnetic needle, or the variation of the compass.

In 1730, he was removed from the port of Croisci to that of Havre, which brought him into a nearer connection with the Academy of Sciences, in which he obtained, in 1731, the place of associate geometrician, vacant by the promotion of Maupertuis to that of pensioner; and in 1735 he was promoted to the office of pensioner-astronomer. The same year he was sent on the commission to South America, along with Messieurs Godin, Condamine, and Jussieu, to determine the measure of the degrees of the meridian, and the figure of the earth. In this painful and troublesome business, of ten years duration, chiefly among the lofty Cordelier mountains, our author determined many other new circumstances, beside the main object of the voyage; such as the expansion and contraction of metals and other substances, by the sudden and alternate changes of heat and cold among those mountains; observations on the refraction of the atmosphere from the tops of the same, with the singular phenomenon of the sudden increase of the refraction, when the star can be observed below the line of the level; the laws of the density of the air at different heights, from observations made at different points of these enormous mountains; a determination that the mountains have an effect upon a plummet, though he did not assign the exact quantity of it; a method of estimating the errors committed by navigators in determining their route; a new construction of the log for measuring a ship's way; with several other useful improvements.

Other inventions of Bouguer, made upon different occasions, were as follow: the heliometer, being a telescope with two object glasses, affording a good method of measuring the diameters of the larger planets with ease and exactness: his researches on the figure in which two lines or two long ranges of parallel trees appear: his experiments on the famous reciprocation of the pendulum; and those upon the manner of measuring the force of the light; &c. &c.

The close application which Bouguer gave to study, undermined his health, and terminated his life the 15th of August, 1758, at 60 years of age. His chief works, that have been published, are, 1. "The Figure of the Earth, determined by the observations made in South America;" 1749, in 4to. 2. "Treatise on Navigation and Pilotage;" Paris, 1752, in 4to. This work has been abridged by M. La Caille, in one volume, 8vo. 1768. 3. "A Treatise on Ships, their Construction and Motions;" in 4to., 1756. 4. "An Optical Treatise on the Gradation of Light;" first in 1729; then a new edition in 1760, in 4to. and a great

number of papers inserted in the Memoirs of the Academy.

BOUNTY, a bounty in political economy, is a sum of money paid by the state for the raising or the exporting of some species of rude produce or manufacture. In this country every person who raises a certain quantity of flax is entitled to a bounty; and when corn is below a certain price, a bounty of so much per bushel is paid on its exportation.

The intention of bounties is to encourage the production of those articles on which they are paid, by securing a profitable return to the producer.

The effect of a bounty on the production of any article is to render it cheaper in the home market—thus, if the fair or customary profit on the capital employed be 10 per cent., and the bounty amount to 5 per cent. on the capital, it is evident the grower can afford to sell the article 5 per cent. cheaper than he otherwise could.

The effect of a bounty on the exportation of any article is to render it dearer in the home market—for by means of it the surplus of the home market can be removed on easier terms than could otherwise be possible to the foreign market, and thus a reduction of price is prevented.

But if the redundance of the home market could not be exported, and the price consequently was reduced, production would be discouraged, and the supply being more scanty, the price might be as high or higher than it is rendered by the bounty. For a more particular inquiry into the effects of a bounty on exportation see CORN LAWS.

The objection to all bounties is the following: "that every branch of trade in which the merchant can sell his goods for a price which replaces to him, with the ordinary profits of stock, the whole capital employed in preparing and sending them to market, can be carried on without a bounty. Every such branch is evidently upon a level with all the other branches of trade which are carried on without bounties, and cannot therefore require one more than they. Those trades only require bounties in which the merchant is obliged to sell his goods for a price which does not replace to him his capital together with the ordinary profit, or in which he is obliged to sell them for less than it really costs him to send them to market. The bounty is given in order to make up this loss, and to encourage him to continue, or perhaps to begin a trade, of which the expense is supposed to be greater than the returns, of which every operation eats up a part of the capital employed in it, and which is of such a nature that if all other trades resembled it, there would soon be no capital left in the country. See DRAWBACK, PREMIUM.

BOW, a weapon of offence made of steel, wood, horn, or other elastic matter, which, after being bent by means of a string fastened to its two ends, in returning to its natural state, throws out an arrow with prodigious force.

The use of the bow is, without all doubt, of the earliest antiquity. It has likewise been the most universal of all weapons, having obtained among the most barbarous and remote people, who had the least communication with the rest of mankind.

The figure of the bow is pretty much the same in all countries, where it has been used; for it has generally two inflexions or bendings, between which, in the place where the arrow is drawn, is a right line. The Grecian bow was in the shape of a Σ, of which form we meet with many, and generally adorned with gold or silver. The Scythian bow was distinguished from the bows of Greece and other nations by its incurvation, which was so great, as to form an half-moon or semicircle.

The matter of which bows were made, as well as their size, differed in different countries. The Persians had very great bows made of reeds; and the Indians had also, not only arrows, but bows made of the reeds or canes of that country; the Lycian bows were made of the cornel tree; and those of the Æthiopians, which surpassed all others in magnitude, were made of the palm-tree.

Though it does not appear that the Romans made use of bows in the infancy of their republic, yet they afterwards admitted them as hostile weapons, and employed auxiliary archers in all their wars.

In drawing the bow, the primitive Grecians did not pull back their hand towards their right ear, according to the fashion of modern ages, and of the ancient Persians, but placing their bow directly before them, returned their hand upon their right breast. This was also the custom of the Amazons.

The bow is a weapon of offence amongst the inhabitants of Asia, Africa, and America, at this day; and in Europe, before the

invention of fire arms, a part of the infantry were armed with bows.

Lewis XI. first abolished the use of them in France, introducing, in their place, the halbard, pike, and broad sword. The long bow was formerly in great vogue in England, and many laws were made to encourage the use of it. The parliament under Henry VIII. complaining of the disuse of long bows, heretofore the safeguard and defence of this kingdom, and the dread and terror of its enemies.

Bow, in music, an instrument, which, being drawn over the strings of a musical instrument, makes it resound. It is composed of a small stick, to which are fastened eighty or an hundred horse hairs, and screw which serves to give these hairs the proper tension. In order that the bow may touch the strings briskly, it is usual to rub the hairs with rosin. The bow of the violin is now about 28 inches long.

Bow, among artificers, an instrument so called from its figure; in use among gunsmiths, locksmiths, watch-makers, &c. for making a drill go. Among turners, it is the name of that pole fixed to the ceiling, to which they fasten the cord that whirls round the piece to be turned.

Bow *of a ship*, that part of her head which is contained between the stern and the after-part of the fore-castle, on either side; so that a ship hath two bows, the starboard and the larboard, or, as they are sometimes called, the weather and the lee bow.

BOWLING, the art of playing at bowls. The first thing to be observed in bowling is, the right choosing your bowl, which must be suitable to the ground you design to run on. Thus, for close alleys, the flat bowl is the best; for open grounds of advantage, the round byassed bowl; and for plain and level swards, the bowl that is as round as a ball. The next is to choose your ground; and lastly to distinguish the risings, fallings, and advantages of the places where you bowl.

Bowling, Bow-line, in a ship, a rope made fast to the leech or middle part of the outside of the sail: it is fastened by two, three, or four ropes, like a crow's foot, to as many parts of the sail; only the mizen bowling is fastened to the lower end of the yard. This rope belongs to all sails, except the sprit-sail and sprit-top-sails. The use of the bowling is to make the sails stand sharp or close, or by a wind.

"Sharp the bowling," is hale it taught, or pull it hard. "Hale up the bowling," that is pull it harder forward on. "Check or ease, or run up the bowling," that is let it be more slack.

BOWSE, in the sea-language, signifies as much as to hale or pull. Thus bowsing upon a tack, is haling upon a tack. Bowse away, that is pull away all together.

BOWSPRIT, or Boltspit, a kind of mast, resting slopewise on the head of the main stem, and having its lower end fastened to the partners of the fore-mast, and farther supported by the fore stay. It carries the sprit-sail, sprit-top-sail, and jack-staff, and its length is usually the same with that of the fore-mast.

BOWYERS, artificers, whose employment or occupation it is to make bows. There is a company of bowyers in the city of London, first incorporated in 1623.

BOX. See Buxus.

The turner, engraver, carver, mathematical instrument, comb, and pipe makers, give a great price for this wood by weight, as well as by measure. It makes wheels or shivers, pins for blocks and pullies, pegs for musical instruments, nut-crackers, weavers' shuttles, collar-sticks, bump-sticks and dressers for shoemakers, rulers, rolling-pins, pestles, mall-balls, beetles, tops, tallies, chess-men, screws, bobbins, cups, spoons, and the strongest of all axle-trees.

The box-tree formerly grew in great plenty, near Dorking in Surry, but only a few of the large trees are now left. Boxwood is chiefly imported from the Levant, sometimes from Spain.

BOYAU, in fortification, a ditch covered with a parapet, which serves as a communication between two trenches. It runs parallel to the works of the body of the place, and serves as a line of contravallation, not only to hinder the sallies of the besieged, but also to secure the miners. But when it is a particular cut that runs from the trenches to cover some spot of ground, it is drawn so as to be enfiladed, or scoured by the shot from the town.

BOYLE (Robert), one of the greatest philosophers, as well as best men, that any country has ever produced, was the seventh son, and the fourteenth child, of Richard Earl of Cork, and born at Lismore, in the province of Munster in Ireland, the 25th of January, 1626–7; the very year of the death of the learned Lord Bacon, whose plans of experimental philosophy he afterwards so ably seconded, that it was said of him, that he was the person designed by nature to succeed to the labours and inquiries of that

extraordinary genius. While very young, he was instructed in his father's house to read and write, and to speak French and Latin. In 1635, when only eight years old, he was sent over to England, to be educated at Eton school. Here he soon discovered extraordinary powers of understanding, with a disposition to cultivate and improve it to the utmost.

After remaining at Eton between three and four years, his father sent him and his brother Francis, in 1638, on their travels upon the continent. They passed through France to Geneva, where they settled for some time to pursue their studies: here he resumed his acquaintance with the elements of the mathematics, which he had commenced at Eton when ten years old.

In the autumn of 1641, he quitted Geneva, and travelled through Switzerland and Italy to Venice, from whence he returned again to Florence, where he spent the winter, studying the Italian language and history, and the works of the celebrated astronomer Galileo, who died in a village near this city during Mr. Boyle's residence here.

About the end of March, 1642, he set out from Florence, visited Rome and other places in Italy, then returned to the south of France, and came back to England in 1644.

From this time, Mr. Boyle's chief residence, for some years at least, was at his manor of Stalbridge, from whence he made occasional excursions to Oxford, London, &c.; applying himself with great industry to various kinds of studies, but especially to philosophy and chemistry; and seizing every opportunity of cultivating the acquaintance of the most learned men of his time. He was one of the members of that small but learned body of men, who, when all academical studies were interrupted by the civil wars, secreted themselves about the year 1645, and held private meetings, first in London, afterwards at Oxford, to cultivate subjects of natural knowledge upon that plan of experiment which Lord Bacon had delineated. They styled themselves then the Philosophic College; but after the restoration, when they were incorporated, and distinguished openly, they took the name of the Royal Society.

In the summer of 1654, he went to settle at Oxford, the Philosophical Society being removed from London to that place, that he might enjoy the conversation of the other learned members, his friends, who had retired thither, such as Wilkins, Wallis, Ward, Willis, Wren, &c. It was during his residence here that he improved that admirable engine the air-pump; and by numerous experiments was enabled to discover several qualities of the air, so as to lay a foundation for a complete theory. But philosophy, and inquiries into nature, though they engaged his attention deeply, did not occupy him entirely; as he still continued to pursue critical and theological studies. He had offers of preferment to enter into holy orders, by the government, after the restoration. But he declined the offer, choosing rather to pursue his studies as a layman, in such a manner as might be most effectual for the support of religion; and began to communicate to the world the fruits of these studies.

In the year 1663, the Royal Society being incorporated by King Charles II. Mr. Boyle was named one of the council; and as he might justly be reckoned among the founders of that learned body, so he continued one of the most useful and industrious of its members during the whole course of his life.

In 1688, Mr. Boyle's health declining very much, he abridged greatly his time given to conversations and communications with other persons, to have more time to prepare for the press some others of his papers, before his death; he died on the last day of December of the same year 1691, in the 65th year of his age, and was buried in St. Martin's church in the Fields, Westminster; his funeral sermon being preached by Dr. Gilbert Burnet, Bishop of Salisbury; in which he displayed the excellent qualities of our author, with many circumstances of his life, &c. He represents him as being well acquainted with the whole compass of the mathematical sciences, and as well versed even in the most abstruse parts of geometry.

Mr. Boyle left also several papers behind him, which have been published since his death. Beautiful editions of all his works have been printed at London, in 5 volumes folio, and six volumes 4to. Dr. Shaw also published in three volumes 4to., the same works "abridged, methodized, and disposed under the general heads of Physic, Statics, Pneumatics, Natural History, Chemistry, and Medicine;" to which he has prefixed a short catalogue of the philosophical writings, according to the order of time when they were first published. The character of this great man can be only estimated by an attention to his works, reflecting, at the

same time, on the state of science at the period in which he lived. He was distinguished by the comprehensiveness of his views, and the extent and variety of his researches; by indefatigable diligence, and invincible perseverance, in his collection of facts and investigation of their causes; by a total freedom from any preconceived attachment to theories and systems; by candour in discussing the opinions of others; and by fidelity and modesty in the narration of his own performances.

B QUADRO, QUADRATO, or DURALE, in music, called by the French b quarre, from its figure ♮. This is what we call B natural or sharp, in distinction to B mol or flat. See FLAT and

If the flat ♭ be placed before a note in the thorough bass, it intimates that its third is to be minor; and if placed with any cypher over a note in the bass, as ♭ 6, or ♭ 5, &c. it denotes, that the fifth or sixth thereto are to be flat. But if the quadro ♮ be placed over any note, or with a cypher, in the thorough bass, it has the contrary effect; for thereby the note or interval thereto is raised to its natural order.

BRABEIUM, in botany, a genus of the Polygamia Monoecia class and order. Essential character: herm. scales of the ament; corol four-parted, revolute above; stamens four; pistil one; drupe roundish; seed globular; male, scales of the ament; corol four or five-parted; stamens four, inserted into the throat; style bifid, abortive. There is only one species, with its varieties, *viz.* B. stellulifolium, or African almond, rises with an upright stem, which is soft and full of pith, and covered with a brown bark. Horizontal branches are sent out at every joint, the lower ones being longest, and every tier diminishing to the top, so as to form a sort of pyramid. The flowers are produced near the ends of the shoots, coming out from between the leaves, quite round the branches, they are of a pale colour inclining to white, they appear early in the spring, and fall away without any fruit succeeding them in this country. It is a native of the country about the Cape of Good Hope.

BRACE, in architecture, a piece of timber framed in with bevil joints, the use of which is to keep the building from swerving either way. When the brace is framed into the king-pieces, or principal rafters, it is by some called a strut.

BRACES, in the sea-language, are ropes belonging to all the yards of a ship, except the mizen, two to each yard, reeved through blocks that are fastened to pennants, seized to the yard-arms. Their use is either to square, or traverse the yards. Hence to brace the yard, is to bring it to either side. All braces come aftward on, as the main brace comes to the poop, the main-top-sail brace comes to the mizen-top, and thence to the main shrouds: the fore and fore-top-sail braces come down by the main and main-top-sail stays, and so of the rest. But the mizen-bowline serves to brace to the yard, and the cross-jack braces are brought forwards to the main-shrouds when the ship sails close by a wind.

BRACES, in music, are those double curves which are placed at the beginning of the staves of any composition. Their use is to bend together the harmonizing parts, and lead the eye with facility from one set of staves to another. In those scores which include a part for a keyed instrument, as the organ, harpsicord, or piano-forte, it is usual to draw a smaller brace within the great one, to include and to distinguish from the other parts of the score the two staves designed for either of those instruments.

BRACES to a drum, the cords which are distended in oblique lines from the head to the bottom round the exterior of the drum, and which by tightening or relaxing the parchment, serve to raise or flatten the tone.

BRACELET, an ornament worn on the wrist, much used among the ancients: it was made of different materials, and in different fashions, according to the age and quality of the wearer. Bracelets are still worn by the savages of Africa, who are so excessively fond of them, as to give the richest commodities, and even their fathers, wives, and children, in exchange for those made of no richer materials than shells, glass, beads, and the like.

BRACHIÆUS, in anatomy, a name given to two muscles, which are flexors of the cubitus, and distinguished by the appellations of *externus* and *internus*. See ANATOMY.

BRACHMANS, a sect of Indian philosophers, known to the ancient Greeks by the name of Gymnosophists. The ancient Brachmans lived upon herbs and pulse, and abstained from every thing that had life in it. They lived in solitude, without matrimony, and without property; and they wished ardently for death, considering life only as a burden. The modern Brachmans make up one of the casts or tribes of the Banians. They are the priests of that

people, and perform their office of praying and reading the law, with several mimical gestures, and a kind of quavering voice. They believe, that, in the beginning, nothing but God and the water existed, and that the Supreme Being, desirous to create the world, caused the leaf of a tree, in the shape of a child playing with its great toe in its mouth, to float on the water. From its navel there issued out a flower, whence Brama drew his original, who was intrusted by God with the creation of the world, and presides over it with an absolute sway. They make no distinction between the souls of men and brutes, but say the dignity of the human soul consists in being placed in a better body, and having more room to display its faculties. They allow of rewards and punishments after this life; and have so great a veneration for cows, that they look on themselves as blessed, if they can but die with the tail of one of them in their hand. They have preserved some noble fragments of the knowledge of the ancient Brachmans. They are skilful arithmeticians, and calculate, with great exactness, eclipses of the sun and moon. They are remarkable for their religious austerities. One of them has been known to make a vow, to wear about his neck a heavy collar of iron for a considerable time: another to chain himself by the foot to a tree, with a firm resolution to die in that place: and another to walk in wooden shoes stuck full of nails on the inside. Their divine worship consists chiefly of processions, made in honour of their deities. They have a college at Banara, a city seated on the Ganges.

BRACHURUS, the name of a genus of animalcules, with tails shorter than their bodies, and no visible limbs.

BRACHYGLOTTIS, in botany, a genus of the Syngenesia Superflua class and order. Receptacle naked; down feathery; calyx cylindrical, simply equal; florets of the disk five-cleft. There are two species, natives of the South Sea Islands.

BRACHYGRAPHY, the art of short-hand-writing. See SHORT-HAND.

BRACKETS, in a ship, the small knees, serving to support the galleries, and commonly carved. Also the timbers that support the gratings in the head, are called brackets.

BRACKETS, in gunnery, are the cheeks of the carriage of a mortar: they are made of strong planks of wood, of almost a semicircular figure, and bound round with thick iron plates; they are fixed to the beds by four bolts, which are called bed-bolts; they rise up on each side of the mortar, and serve to keep her at any elevation, by means of some strong iron bolts, called bracket-bolts, which go through these cheeks or brackets.

BRADLEJA, in botany, so named from Richard Bradley, F. R. S. first professor of botany at Cambridge, a genus of the Monoecia Monadelphia class and order. Essential character: male calyx none; corol petals six, nearly equal; filaments three, with three twin anthers; female calyx none; corol six-parted, three parts interior; germ superior, with six to eight stigmas; capsules six-celled, six-valved; seed solitary. There are three species, B. sinica, Chinese bradleja, is a shrub with leaves resembling the annona, but not of a lucid surface. The fructifications proceed from the axils of the leaves. The fruits or seed-vessels are compressed, small or bicular, straited and hard. B. zeylanica, is a Ceylonese shrub. B. glochidium, is a shrub which grows in the Islands of the Southern or Pacific Ocean.

BRADLEY (DR. JAMES), a celebrated English astronomer, the third son of William Bradley, was born at Sherborne in Gloucestershire, in the year 1692. He went to ford, and was admitted a commoner of Baliol College, March 15, 1710, where he took the degree of bachelor the 14th of Oct. 1714, and of master of arts the 21st of January, 1716. His friends intending him for the church, his studies were regulated with that view; and as soon as he was of a proper age to receive holy orders, the Bishop of Hereford, who had conceived a great esteem for him, gave him the living of Bridstow, and soon after he was inducted to that of Landewy Welfry, in Pembrokeshire.

He was nephew to Mr. Pound, a gentleman well known in the learned world, by many excellent astronomical and other observations, and who would have enriched it much more, if the journals of his voyages had not been burnt at Pulo Condor, when the place was set on fire, and the English who were settled there cruelly massacred, Mr. Pound himself very narrowly escaping with his life. With this gentleman, at Wanstead, Mr. Bradley passed all the time that he could spare from the duties of his function; being then sufficiently acquainted with the mathematics to improve by Mr. Pound's conversation. It may easily be imagined that the example and conversation of this gentleman did not render Bradley more

fond of his profession, to which he had before no great attachment: he continued, however, as yet to fulfil the duties of it, though at this time he had made such observations as laid the foundation of those discoveries which afterward distinguished him as one of the greatest astronomers of his age. These observations gained him the notice and friendship of the Lord Chancellor Macclesfield, Mr. Newton, afterward Sir Isaac, Mr. Halley, and of many other members of the Royal Society, into which he was soon after elected a member.

Soon after, the chair of Savilian professor of astronomy at Oxford became vacant, by the death of the celebrated Dr. John Keil, and Mr. Bradley was elected to succeed him on the 31st of October, 1721, at 29 years of age: his colleague being Mr. Halley, who was professor of geometry on the same foundation. Upon this appointment, Mr. Bradley resigned his church livings, and applied himself wholly to the study of his favourite science. In the course of his observations, which were almost innumerable, he discovered and settled the laws of the alterations of the fixed stars, from the progressive motion of light, combined with the earth's annual motion about the sun, and the nutation of the earth's axis, arising from the unequal attraction of the sun and moon on the different parts of the earth. The former of these effects is called the "aberration" of the fixed stars, the theory of which he published in 1727; and the latter the "nutation" of the earth's axis, the theory of which appeared in 1737: so that in the space of about ten years he communicated to the world two of the finest discoveries in modern astronomy, which will for ever make a memorable epoch in the history of that science. See ABERRATION and NUTATION.

In 1730 Mr. Bradley succeeded Mr. Whiteside, as lecturer in astronomy and experimental philosophy in the Museum at Oxford: which was a considerable emolument to him, and which he held till within a year or two of his death, when his ill state of health induced him to resign it. He always preserved the esteem and friendship of Dr. Halley; who, being worn out by age and infirmities, thought he could not do better for the service of astronomy than procure for Mr. Bradley the place of regius professor of astronomy at Greenwich, which he himself had many years possessed with the greatest reputation. With this view he wrote many letters, desiring Mr. Bradley's permission to apply for a grant of the reversion of it to him, and even offered to resign it in his favour, if it should be thought necessary; but Dr. Halley died before he could accomplish this kind object. Dr. Bradley however obtained the place in February, 1741-2, by the interest of Lord Macclesfield, who was afterward president of the Royal Society, and upon this appointment the University of Oxford sent him a diploma of doctor of divinity.

This appointment of astronomer royal at Greenwich, which was dated the 3d of February, 1741-2, placed Mr. Bradley in his proper element, and he pursued his observations with unwearied diligence. However numerous the collection of astronomical instruments at that observatory, it was impossible that such an observer as Dr. Bradley should not desire to increase them, as well as to answer those particular views, as in general to make observations with greater exactness. In the year 1748, therefore, he took the opportunity of the visit of the Royal Society to the observatory, annually made to examine the instruments and receive the professor's observations for the year, to represent so strongly the necessity of repairing the old instruments, and providing new ones, that the Society thought proper to make application to the king, who was pleased to order one thousand pounds for that purpose. This sum was laid out under the direction of our author, who, with the assistance of the late celebrated Mr. Graham and Mr. Bird, furnished the observatory with as complete a collection of astronomical instruments as the most skilful and diligent observer could desire.

During Dr. Bradley's residence at the Royal Observatory, the living of the church at Greenwich became vacant, and was offered to him: upon his refusing to accept it, from a conscientious scruple, "that the duty of a pastor was incompatible with his other studies and necessary engagements," the king was pleased to grant him a pension of 250*l.* over and above the astronomer's original salary from the Board of Ordnance, "in consideration (as the sign manual, dated the 15th Feb. 1752, expresses it) of his great skill and knowledge in the several branches of astronomy and other parts of the mathematics, which have proved so useful to the trade and navigation of this kingdom." A pension which has been regularly continued to the astronomers royal ever since.

About 1748 our author became entitled

to Bishop Crew's benefaction of 30*l.* a year to the lecture reader in experimental philosophy at Oxford. He was elected a member of the Academy of Sciences at Berlin in 1747; of that at Paris in 1748; of that at Petersburgh in 1754; and of that at Bologna in 1757. He was married in the year 1744; but never had more than one child, a daughter.

By too close application to study and observations, Dr. Bradley became afflicted for near two years before his death with a grievous oppression on his spirits; which interrupted his useful labours. This distress arose chiefly from an apprehension that he should outlive his rational faculties: but this so much dreaded evil never came upon him. In June, 1762, he was seized with a suppression of urine, occasioned by an inflammation in the reins, which terminated his existence the 13th of July following. His death happened at Chalfont, in Gloucestershire, in the 70th year of his age, and he was interred at Minchinhampton, in the same county.

As to his character, Dr. Bradley was remarkable for a placid and gentle modesty, very uncommon in persons of an active temper and robust constitution. Although he was a good speaker, and possessed the rare but happy art of expressing his ideas with the utmost precision and clearness, yet no man was a greater lover of silence, for he never spoke but when he thought it absolutely necessary. Nor was he more inclined to write than to speak, as he has published very little: he had a natural diffidence which made him always afraid that his works might injure his character; so that he suppressed many which might have been worthy of publication. Many of his papers have been inserted in the Philosophical Transactions.

The public character of Dr. Bradley, as a man of science and observation, is fully established by his various works. His private character was in every respect estimable. That he published so little may be ascribed to a large share of diffidence, which prevented him from soliciting that attention which at all times he could command. His observations made at the Royal Observatory during 20 years were comprized in 13 vols. folio and two 4to.; these were transferred in the year 1776 to the University of Oxford, on condition they should be printed and published by that learned body. In June, 1791, the Board of Longitude seeing no prospect of their publication, passed some resolutions respecting the public right to these observations, which being transmitted to the vice chancellor, the Board was in consequence informed, that the delegates of the press in the university were proceeding with the work. The first volume was published in 1798, in a very splendid form, under the title of "Astronomical observations at Greenwich, from the year 1750 to the year 1762."

BRADS, among artificers, a kind of nails used in building, which have no spreading head as other nails have.

BRADYPUS, *the sloth*, in natural history, a genus of Mammalia, of the order Bruta. Generic character: cutting teeth, none in either jaw; canine teeth obtuse, single, longer than the grinders, placed opposite; grinders five on each side, obtuse; fore-legs much longer than the hind; claws very long. See Plate II. Mammalia, fig. 6. There are three species, of which we shall give a brief account. B. tridactylus, or three-toed sloth: the general appearance of the sloth is extremely uncouth; the body is of a thick shape; the fore-legs short, the hinder ones far longer; the feet on all the legs are very small, but are armed each with three most excessively strong and large claws, of a slightly curved form, and sharp-pointed: the head is small; the face short, with a rounded or blunt snout, which is naked and of a blackish colour; the eyes are small, black, and round; the ears rather small, flat, rounded, lying close to the head, and not unlike those of monkeys: the hair on the top of the head is so disposed as to project somewhat over the forehead and sides of the face, giving a very peculiar and grotesque physiognomy to the animal. The general colour of the hair on all parts is a greyish brown; and the hair is extremely coarse, moderately long, and very thickly covers the body, more especially about the back and thighs. A remarkable character as to colour in this species, is a wide patch or space on the upper part of the back, of a bright ferruginous, or rather pale orange colour, spotted on each side with black, and marked down the middle with a very conspicuous black stripe, wide at its origin, and gradually tapering to its extremity; it reaches more than half way down the back, and terminates in a sort of trifid mark. The tail is nearly imperceptible, being so extremely short as to be concealed from view by the fur.

The sloth feeds entirely on vegetables, and particularly on leaves and fruit. Its

voice is said to be so inconceivably singular, and of such a mournful melancholy, attended, at the same time, with such a peculiarity of aspect as at once to excite a mixture of pity and disgust: and it is added, that the animal makes use of this natural yell as its best mode of defence; since other creatures are frightened away by the uncommon sound. This, however, is far from being its only refuge; for so great is the degree of muscular strength which it possesses, that it is capable of seizing a dog with its claws, and holding it, in spite of all its efforts to escape, till it perishes with hunger; the sloth itself being so well calculated for supporting abstinence, that the celebrated Kircher assures us of its power in this respect, having been exemplified by the very singular experiment of suffering one, which had fastened itself to a pole, to remain in that situation, without any sustenance, upwards of forty days. This extraordinary animal is an inhabitant of the hotter parts of South America. It is nearly as large as a middle-sized dog.

B. Didactylus, or two-toed sloth, is also a native of South America; and it is asserted, on good authority, that it is likewise found in some parts of India, as well as in the island of Ceylon. In its general appearance, as well as in size, it bears a considerable resemblance to the former species: it is, however, somewhat more slender in its shape, covered with smoother or less coarse and harsh hair, and is of a more uniform or less varied tinge; and, in particular, is strikingly distinguished, as a species, by having only two claws on the fore-feet; it is also a much more active animal, and, even when imported into Europe, has been known, according to the testimony of the Count de Buffon, to ascend and descend from a tall tree several times in a day; whereas the three-toed sloth with difficulty performs that operation in a whole day, and can scarcely crawl a few hundred yards in the space of many hours.

B. Ursinus, or ursine sloth, is by far the largest species: it is a native of India, and has been but lately introduced to the knowledge of European naturalists. It was brought from the neighbourhood of Patna in Bengal. This animal has, at first sight, so much of the general aspect of a bear, that it has actually been considered as such by some observers: but it is no otherwise related to the bear than by its size and habit, or mere exterior outline. It is about the size of a bear and is covered all over, except on the face, or rather the snout, which is bare and whitish, with long shaggy black hair, which on the neck and back is much longer than elsewhere: on the fore part of the body the hair points forwards; on the hinder part backwards: the eyes are very small; the ears rather small, and partly hid in the long hair of the head: it is totally destitute of incisores, or front teeth; in each jaw there are two canine teeth of a moderate size: the nose or snout is of a somewhat elongated form; it also appears as if furnished with a sort of transverse joint, or internal cartilage, which admits of a peculiar kind of motion in this part. It is a gentle and good natured animal; it feeds chiefly on vegetables and milk, is fond of apples, and does not willingly eat animal food, except of a very tender nature, as marrow, which it readily sucked from a bone presented it. Its motions are not, as in the two former species, slow and languid, but moderately lively; and it appears to have a habit of turning itself round and round every now and then, as if for amusement, in the manner of a dog when lying down to sleep. It is said to have a propensity to burrowing under the ground.

BRAG, an ingenious and pleasant game at cards, wherein as many may partake as the cards will supply, the eldest hand dealing three to each person at one time, and turning up the last card all round. This done, each gamester puts down three stakes, one for each card. The first stake is won by the best card turned up in the dealing round; beginning from the ace, king, queen, knave, and so downwards. When cards of the same value are turned up to two or more of the gamesters, the eldest hand gains; but it is to be observed, that the ace of diamonds wins, to whatever hand it be turned up.

The second stake is won by what is called the brag, which consists in one of the gamesters challenging the rest to produce cards equal to his: now it is to be observed, that a pair of aces is the best brag, a pair of kings the next, and so on; and a pair of any sort wins the stake from the most valuable single card. In this part consists the great diversion of the game; for, by the artful management of the looks, gestures, and voice, it frequently happens, that a pair of fives, treys, or even duces, out-brags a much higher pair, and even from pairs royal, to the no small merriment of the company. The knave of clubs is here a principal favourite, making a pair with any other

Scott sc.

Fig. 1. Arctomys marmota: Alpine Marmot. Fig. 2. A. empetra: Quebec Marmot. Fig. 3. A. Monax: Maryland Marmot. – Fig. 4. Hamster. – Fig. 5. Lapland Marmot. – Fig. 6. Bradypus tridactylus: three toed Sloth.

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card in hand, and with any other two cards a pair royal.

The third stake is won by the person, who first makes up the cards in his hand one and thirty; each dignified card going for ten, and drawing from the pack as usual in this game.

BRAHE (TYCHO), a celebrated astronomer, descended from a noble family originally of Sweden but settled in Denmark, was born the 14th of December, 1546, at Knudstrop, in the county of Schonen, near Helsinbourg. He was taught Latin when seven years old, and studied five years under private tutors. His father dying while he was very young, his uncle, George Brahe, adopted him, and sent him in 1559 to study philosophy and rhetoric at Copenhagen. The great eclipse of the sun, on the 21st of August, 1560, happening at the precise time the astronomers had foretold, he began to consider astronomy as something divine; and purchasing the tables of Stadius, he gained some notion of the theory of the planets. In 1562 he was sent by his uncle to Leipsic to study the law, where his acquirements gave manifest indications of extraordinary abilities. His natural inclination, however, was to the study of the heavens, to which he applied himself so assiduously, that, notwithstanding the care of his tutor to keep him close to the study of the law, he made use of every means in his power for improving his knowledge of astronomy; he purchased with his pocket money whatever books he could meet with on the subject, and read them with great attention, procuring assistance in difficult cases from Bartholomew Schultens, his private tutor; and having procured a small celestial globe, he took opportunities, when his tutor was in bed, and when the weather was clear, to examine the constellations in the heavens, to learn their names from the globe, and their motions from observation.

After a course of three years study at Leipsic, his uncle dying, he returned home in 1565. In this year, at a wedding-feast, a difference arising between Brahe and a Danish nobleman, they fought, and our author had part of his nose cut off by a blow: a defect which he so artfully supplied with one made of gold and silver, that it was scarcely perceivable. About this time he began to apply himself to chemistry, proposing nothing less than to obtain the philosopher's stone.

In 1571 he returned to Denmark; and was favoured by his maternal uncle, Steno Billes, a lover of learning, with a convenient place at his castle of Herritzvad near Knudstorp, for making his observations, and building a laboratory. And here it was he discovered, in 1573, a new star in the constellation Cassiopeia. But soon after, his marrying a country girl, beneath his rank, occasioned so violent a quarrel between him and his relations, that the king was obliged to interpose to reconcile them.

In 1574, by the king's command, he read lectures at Copenhagen on the theory of the planets. The year following he began his travels through Germany, and proceeded as far as Venice. He then resolved to remove his family, and settle at Basil; but Frederick the Second, King of Denmark, being informed of his design, and unwilling to lose a man who was capable of doing so much honour to his country, he promised to enable him to pursue his studies, and bestowed upon him for life the island of Haen in the Sound, and promised that an observatory and laboratory should be built for him, with a supply of money for carrying on his designs: and accordingly the first stone of the observatory was laid the 8th of August, 1576, under the name of Uranibourg. The king also gave him a pension of 2000 crowns out of his treasury, a fee in Norway, and a canonry of Roshild, which brought him in 1000 more. This situation he enjoyed for the space of about twenty years, pursuing his observations and studies with great industry: here he kept always in his house ten or twelve young men, who assisted him in his observations, and whom he instructed in astronomy and mathematics. Here also he received a visit from James the Sixth, King of Scotland, afterward James the First of England, having come to Denmark to espouse Anne, daughter of Frederick the Second. James made our author some noble presents, and wrote a copy of Latin verses in his praise.

Brahe's tranquillity, however, in this happy situation was at length fatally interrupted. Soon after the death of King Frederick, by the aspersions of envious and malevolent ministers, he was deprived of his pension, fee, and canonry, in 1596. Being thus rendered incapable of supporting the expenses of his establishment, he quitted his favourite Uranibourg, and withdrew to Copenhagen, with some of his instruments, and continued his astronomical observations and chemical experiments in that city, till the same malevolence procured from the new King, Charles the Fourth, an order for him to dis-

continue them. This induced him to fall upon means of being introduced to the Emperor Rodolphus, who was fond of mechanism and chemical experiments: and to smooth the way to an interview, Tycho now published his book, "Astronomia instaurata Mechanica," adorned with figures, and dedicated it to the Emperor. That prince received him at Prague with great civility and respect; gave him a magnificent house till he could procure one for him more fit for astronomical observations; he also assigned him a pension of 3000 crowns; and promised him a fee for himself and his descendants. Here then he settled in the latter part of 1598, with his sons and scholars, and among them the celebrated Kepler who had joined him. But he did not long enjoy this happy situation, for about three years after he died, on the 24th of October, 1601, of a retention of urine, in the 55th year of his age, and was interred in a very magnificent manner in the principal church at Prague, where a noble monument was erected to him; leaving, beside his wife, two sons and four daughters. On the approach of death he enjoined his sons to take care that none of his works should be lost; exhorted the students to attend closely to their exercises; and recommended to Kepler the finishing of the Rudolphine Tables which he had constructed for regulating the motion of the planets.

Brahe's skill in astronomy is universally known; and he is famed for being the inventor of a new system of the planets, which he endeavoured, though without success, to establish on the ruins of that of Copernicus. He was very credulous with regard to judicial astrology and presages: if he met an old woman when he went out of doors, or a hare upon the road on a journey, he would turn back immediately, being persuaded that it was a bad omen: also, when he lived at Uranibourg, he kept at his house a madman, whom he placed at his feet at table and fed himself; for as he imagined that every thing spoken by mad persons presaged something, he carefully observed all that this man said; and because it sometimes proved true, he fancied it might always be depended on. He was of a very irritable disposition: a mere trifle put him in a passion; and against persons of the first rank, whom he thought his enemies, he openly discovered his resentment. He was very apt to rally others, but highly provoked when the same liberty was taken with himself. The principal part of his writings are:

1. An account of the New Star which appeared Nov. 11th, 1572, in Cassiopeia; Copenh. 1573, in 4to. 2. Another treatise on the New Phenomena of the Heavens. In the first part of which he treats of the restitution, as he calls it, of the sun and of the fixed stars. And in the second part, of a new star which had then made its appearance. 3. A collection of Astronomical Epistles; printed in 4to. at Uranibourg, in 1596; Nuremberg in 1602; and at Franckfort in 1610. It was dedicated to Maurice Landgrave of Hesse; because there are in it a considerable number of letters of the Landgrave William, his father, and of Christopher Rothmann, the mathematician of that prince, to Tycho, and of Tycho to them. 4. The Rudolphine Tables; which he had not finished when he died; but were revised and published by Kepler, as Tycho had desired. 5. An accurate Enumeration of the Fixed Stars: addressed to the Emperor Rodolphus. 6. A complete Catalogue of 1000 of the Fixed Stars; which Kepler has inserted in the Rudolphine Tables. 7. "Historia Cœlestis," or a History of the Heavens, in two parts: the first contains the observations he had made at Uranibourg, in sixteen books; the latter contains the observations made at Wandesburg, Wittenberg, Prague, &c. in four books.

The apparatus of Tycho was purchased by the Emperor Rodolphus for 22,000 crowns. It remained, however, useless and concealed till the troubles of Bohemia, when the army of the Elector Palatine plundered them, and in the true spirit of barbarism breaking some of them, and applying others to purposes for which they were never designed. The great celestial globe of brass was preserved, carried from Prague, and deposited with the Jesuits of Naysia in Silesia, whence it was afterwards taken, in the year 1633, and placed in the Hall of the Royal Academy at Copenhagen.

BRAIL, or **Brails**, in a ship, are small ropes made use of to furl the sails across: they belong only to the two courses and the mizen-sail; they are reeved through the blocks, seized on each side the ties, and come down before the sail, being at the very skirt thereof fastened to the cringles; their use is, when the sail is furled across, to hale up its bunt, that it may the more easily be taken up or let fall. Hale up the brails, or brail up the sail, that is, hale up the sail, in order to be furled or bound close to the yard.

BRAIN, in anatomy, that soft white mass inclosed in the cranium or skull, in which

all the organs of sense terminate, and in which the soul was formerly supposed principally to reside. See ANATOMY.

The brain and nerves are the instruments of sensation, and even of motion; for an animal loses the power of moving a part the instant that the nerves which enter it are cut. The brain and nerves have a strong resemblance to each other; and it is probable that they agree also in their composition. But hitherto no attempt has been made to analyse the nerves. The brain consists of two substances, which differ from each other somewhat in colour, but which, in other respects, seem to be of the same nature. The outermost matter, having some small resemblance in colour to wood-ashes, has been called the cineritious part; the innermost has been called the medullary part. Brain has a soft feel, not unlike that of soap; its texture appears to be very close; its specific gravity is greater than that of water. When brain is kept in close vessels so that the external air is excluded, it remains for a long time unaltered. Fourcroy filled a glass vessel almost completely with pieces of brain, and attached it to a pneumatic apparatus; a few bubbles of carbonic acid gas appeared at first, but it remained above a year without undergoing any farther change. This is very far from being the case with brain exposed to the atmosphere. In a few days (at the temperature of 60°) it exhales a most detestable odour, becomes acid, assumes a green colour, and very soon a great quantity of ammonia makes it appearance in it. Experiments show that, exclusive of the small proportion of saline ingredients, brain is composed of a peculiar matter, differing in many particulars from all other animal substances, but having a considerable resemblance in many of its properties to albumen. Brain has been compared to a soap; but it is plain that the resemblance is very faint, as scarcely any oily matter could be extricated from brain by Fourcroy, though he attempted it by all the contrivances which the present state of chemistry suggested; and the alkaline portion of it is a great deal too small to merit any attention.

BRAKE, in naval affairs, the handle by which a ship's pump is usually worked; it operates by means of two iron bolts thrust through the inner end of it, one of which rolling across two cheeks, in the upper end of the pump serves as a fulcrum for the brake, supporting it between the cheeks. The other bolt connects the extremity of the brake to the pump spear, which draws up the box or piston charged with the water in the tube.

BRAN, the skins or husks of corn, especially wheat ground, separated from the flour by a sieve or boulter.

It is of wheat-bran that starch-makers make their starch. The dyers reckon bran among the non-colouring drugs, and use it for making, what they call, the sour waters, with which they prepare their several dyes.

BRANCH, in botany, an arm of a tree, or a part, which, sprouting out from the trunk, helps to form the head or crown thereof.

BRANCH is likewise a term used in genealogy and anatomy. Thus we say, the branch of a family, the branch of an artery, the branch of a vein.

BRANCHIÆ, *gills*, in the anatomy of fishes, the parts corresponding to the lungs of land animals, by which fishes take in and throw out again a certain quantity of water, impregnated with air. All fishes, except the cetaceous ones and the petromyzum, are furnished with these organs of respiration; which are always eight in number, four on each side the throat. That next the heart is the least, the rest increasing in order as they stand near the head of the fish.

Each of these gills is composed of a bony lamina, in form of a semicircle, for the most part; and on its convex side stand the leaves or lamellæ, like so many sickles. The whole convex part of the lamellæ is beset with hairs, which are longest near the base, and decrease gradually as they approach towards the point. There are also hairs on the concave side of the lamellæ, but shorter than the others, and continued only to its middle.

The convex side of one lamina is fitted into the concave side of the next superior one; and all of them are connected together by means of a membrane, which reaches from their base half way their height, where it grows thicker, and in some measure resembles a rope. The rest of the lamina is free, and terminates in a very fine and flexible point.

As to the use of these gills, they seem to be designed to receive the blood protruded from the heart into the aorta, and convey it into the extremities of the lamellæ; from whence being returned by veins, it is distributed over the body of the fish.

BRANCHIONUS, in natural history, a genus of insects of the order Infusoria: the character is, body contractile, covered with a shell, and furnished at the head with ciliate votatory organs. There are 12 species: the B. urceolaris is bell-shaped, with the shell many toothed at the tip, and rounded at the base; tail long, and bifid at the end. It is found frequently in stagnant water, appearing to the naked eye as a small white speck; rotatory double organ, which it can protrude and conceal at pleasure. B. striatus, univalve, with an ovate striate shell, six-toothed at the tip, and entire at the base; without tail. It is found in salt water; pellucid, crystalline, truncate on the fore part, and rounded behind; shell varying in form, with 12 longitudinal ribs.

BRANCHIOSTEGOUS, in natural history, according to the Linnæan system, it is the fifth order of fishes, having gills destitute of bony rays. There are ten genera; *viz.*

Balistes	Mormyrus
Centriscus	Ostracion
Cyclopterus	Pegasus
Diodon	Syngnathus
Lophius	Tetrodon.

Most of these are by Dr. Shaw placed among the Cartelaginei.

BRANDY, a spirituous liquor, produced by the distillation of wines of all kinds, and, properly speaking, by no other fermented liquor; though the purely spirituous part of all fermented vinous liquors procured by disillation is essentially the same, and therefore, an infinite variety of imitations of the intermediate products of distillation may be produced by adding flavouring and colouring matters to any kind of pure spirit. Brandy is prepared in many of the wine countries of Europe, and, with particular excellence, in Languedoc, in Anjou, whence the well-known Cogniac brandy, and other parts of the south of France.

Though every wine will give a certain portion of brandy by distillation, it is not every kind that can be used with advantage. In general, the strong heavy wines are to be preferred. Those that do not yield a sixth of their quantity of spirit, are not worth the expense of working. The apparatus is composed of three parts; the alembic, or boiler, the capital fitted on the top of the boiler to receive the spirituous vapour, and the serpentine, or worm, a convoluted pipe, fitting to the beak of the alembic, and immersed in water, in which the vapour is condensed, and flows out at the bottom, in the form of distilled spirit. In distilling care should be taken not to urge the fire too much at first, otherwise the wine boils up into the capital, and comes over into the worm, mixing with and fouling the spirit. In general, the slower the process, and the smaller the stream of spirit from the worm-pipe, the finer and better is the brandy. The distillers make a distinction between the former and the latter runnings of the spirit. What first comes over has the strongest, richest, and highest flavour, and this is gradually lessened, and the spirit becomes more and more watery to the end. Therefore, when the brandy becomes weak, the portion already distilled is set apart, and the remainder is collected in a separate vessel, and is called seconds or feints, in the term of British distillers, and is not immediately fit for use, but is re-distilled with fresh wine in the next process, being still too valuable to be lost. Brandy is naturally clear and colourless as water; for the different shades of colour which it has in commerce arise partly from the casks in which it is kept, but chiefly from the addition of burnt sugar, saunders wood, and other colouring matters, that are intentionally added by the manufacturer, and which appear to do neither good nor harm to the quality of the spirit.

There are several ways of judging of the strength of the spirit. The following is also much used by the dealers: a phial is filled three-quarters with the brandy, stopped with the thumb, and suddenly knocked with some force against the knee. This raises a froth on the surface, and by the size and durability of the bubbles, a good idea may be formed of the strength of the liquor, by those who are in the constant habit of examining samples. This is, however, as liable to error as the trial with gunpowder, burning, &c.: for it is well known, that certain additions may be made to brandy which will very much alter the frothing. After all that has been done, it is still a difficult problem to determine, with perfect accuracy, the strength of all kinds of made spirits, by any shorter method than that of distillation, though the improved hydrometers answer most of the purposes of trade and revenue. The strength of the spirit, of course, depends on the strength of the wine with which it made; and this again depends on the quantity of saccharine mucilage contained in the must or grape-juice, and the perfection of the

fermentation. Generally speaking, the wines of hot climates furnish much more spirit than those of colder: and sweet, rich, well-ripened grapes give much more than the cold, sour, watery fruits. The richest wines furnish as much as a third of spirit; and the general average of the wines in the south of France and Spain is stated to be, by Chaptal, about a fourth. On the other hand, some of the northern wines (though perfect as wines) give no more than a fifteenth of spirit. The manufacture of brandy in other countries very closely resembles the French process which we have just described. Thus, in Spain, the still is filled to four-fifths of its contents with wine, the capital luted on, a fire kindled, and, in about an hour and a half, the spirit begins to come over. About a fifth of the entire quantity of wine is proof spirit, in which olive oil sinks, and comes over fit to be used, without farther process; and as much of inferior and weaker spirit comes over afterwards, which is re-distilled and rectified. When the wines are old, heavy, and oily, and a fine clear spirit is wanted at once, water is added to the wine before distillation, to keep down the oil. The principle distilleries in Spain are in Catalonia.

BRASS, in the arts, a metal much used in various articles of manufacture; it is compounded of zinc and copper, in the proportion of one part of zinc to three of copper. It is of a fine yellow colour, and more fusible than copper, and less liable to tarnish from exposure to the atmosphere. It possesses likewise a considerable degree of malleability and ductility, and can be beat into thin leaves, and drawn into fine wire. Its specific gravity is greater than the mean specific gravity of the two metals. See Zinc.

Brass is manufactured in many countries; but no where more extensively and better than in England, in which both the materials are in great abundance. The ores of zinc are several species of calamine and of blende, called by the miners *black Jack*, which are found abundantly in Devonshire, Derbyshire, and North Wales, generally accompanying lead ores. These are chiefly oxides, or carbonated oxides of zinc, and require a previous calcination before they are fit for brass-making. At Holywell, in Flintshire, the calamine, which is received raw from the mines in the neighbourhood, is first pounded in a stamping-mill, and then washed and sifted in order to separate the lead, with which it is largely admixed. It is then calcined on a broad, shallow, brick hearth, over an oven heated to redness, and frequently stirred for some hours. In some places a conical pile is composed of horizontal layers of calamine, alternating with layers of charcoal, the whole resting on a layer of wood in large pieces, with sufficient intervals for the draught of air. It is then kindled, and the stack continues to burn till the calamine is thoroughly calcined. The calamine, thus prepared, is then ground in a mill, and at the same time mixed with about a third or a fourth part of charcoal, and is then ready for the brass-furnace. The brass-furnace has the form of the frustrum of a hollow cone, or a cone with the apex cut off horizontally. At the bottom of the furnace is a circular grate, or perforated iron plate, coated with clay and horse-dung, to defend it from the action of the fire. The crucibles stand upon the circular plate, forming a circular row, with one in the middle. The fuel, which in England is coal, is thrown round the crucibles, being let down through the upper opening or smaller end of the cone: over this opening is a perforated cover, made of fire-bricks and clay, and kept together with bars of iron, so as to fit closely. This cover serves to regulate the heat in the following manner: the draught of air is formed through an under-ground vault to the ash-hole, thence through the grate and round the crucibles, and through the smaller upper opening into an area where the workmen stand, which is covered by a large dome, and a chimney to convey the smoke into the outer air. When the draught is the strongest, and the heat is required of the greatest intensity, the cover is entirely removed, and the flame then draws through the upper opening of the furnace to a considerable height into the outer brick dome; when the heat is to be lessened, the cover is put on, which intercepts more or less of the draught from the furnace, as more or fewer of the holes of the cover are left unstopped. The crucibles are charged with the mixed calamine and charcoal, together with copper clippings and refuse bits of various kinds, and sometimes brass clippings also, most of which are previously melted and run into a small sunk cistern of water, through a kind of cullender, which divides the metal into globules, like shot. Powdered charcoal is put over all, and the crucibles are then covered and luted up with a mixture of clay or loam and horse dung. The time required for heating the crucibles and completing the process varies considerably

in different works, being determined by custom, by the quantity of materials, the size of the crucibles, and especially the nature of the calamine. In the great way from 10 to 24 hours are required. At Holywell, in Flintshire, about 24 hours are taken.

In the laboratory, brass may be made very well in the small way in a short time. Put into a crucible a mixture of calamine and charcoal, bury it in the requisite proportion of copper shot, cover the whole with charcoal powder, lute on a cover to the crucible, and heat slowly in a wind-furnace for half an hour, till the zinc begins to burn off in a blue flame round the top of the crucible; then raise the fire and heat briskly for half an hour longer. This process of cementation is also shewn by the following management. Put the mixture of calamine and charcoal into a crucible, cover it with a thin layer of clay, over which, when dry, lay a thin plate of copper; cover the whole with fine charcoal powder, and lute on a cover to the crucible. Apply heat gradually, and the vapour of the reduced zinc will rise through the floor of clay, penetrate the red-hot copper plate above it, and gradually convert it into brass, which at the end of the operation will be found lying melted on the stratum of clay. The increase of weight gained by the copper in this operation will afford a good practical test of the goodness of the calamine, and its fitness for brass-making in the great way. The most important properties of brass compared with copper are the following: the colour of brass is much brighter, and more approaching to that of gold; it is more fusible than copper; less subject to rust, and to be acted upon by the vast variety of substances which corrode copper with so much ease; and it is equally malleable when cold, and more extensible than either copper or iron, and hence is well fitted for fine wire. Brass, however, is only malleable when cold. Hammering is found to give a magnetic property to brass, perhaps, however, only arising from the minute particles of iron beaten off the hammer during the process, and forced into the surface of the brass; but this circumstance makes it necessary to employ unhammered brass for compass-boxes, and similar apparatus. The expansion of brass has been very accurately determined, as this metal is most commonly used for mathematical and astronomical instruments, where the utmost precision is required. Mr. Smeaton found that twelve inches in length of cast brass, at 32°, expanded by 180 degrees of heat (or the interval from freezing to boiling water) 225 ten thousandth parts of an inch. Brass wire under the same circumstances expanded 232 parts, an alloy of 16 of brass with 1 of tin expanded 229 parts. The expansion of hammered copper is only 204 such parts: but that of zinc is 253; so that brass holds a middle place in this respect between its two component metals.

Analysis shews a vast variety in the proportions of the different species of brass used in commerce. In general the extremes of the highest and lowest proportions of zinc are from 12 to 25 per cent. of the brass. Even with so much as 25 per cent. of zinc, brass, if well manufactured, is perfectly malleable, though zinc itself scarcely yields to the hammer. Mr. Dizé analyzed a specimen of remarkably fine brass made at Geneva, for the purpose of escapement wheels, and the nicer parts of watch-making, the perfect bars of which bear a very high price. This metal unites great beauty of colour to a very superior degree of ductility. It was found to consist of 75 of copper with 25 of zinc, and probably too the copper was Swedish, or some of the finer sorts. The common brass of Paris seems to contain about 13 per cent. of zinc, the English probably more. The uses of brass are very numerous. It is applicable to a great variety of purposes, is easily wrought by casting and hammering, and by the lathe; its wire is eminently useful, and it takes a high and very beautiful polish. The appearance of brass is given to other metals, by washing them with a yellow laquer or varnish, a substitution often very much to the detriment of the manufactured article. Many other yellow alloys of copper are used, such as bronze, bell-metal, &c. most of which are triple compounds, and will be noticed under the article COPPER.

BRASSICA, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosa or Cruciformes. Cruciferæ, Jussieu. Essential character; calyx erect, converging; seeds globular; a gland between the shorter stamens and the pistil, and between the longer and the calyx. There are sixteen species, among which are the various kinds of cabbages bore-coles; brocolis, and turnips. To give a short account only of this important genus would exceed the limits of our work; we can therefore refer the reader with pleasure to Dr. Rees's New Cyclopedia, where he will find, under the words BRASSICA, and CABBAGE, every information he can de-

sire, and almost every thing that can be interesting on these subjects to the botanist, the gardener, and the farmer.

BRATHYS, in botany, a genus of the Polyandria Pentagynia class and order. Natural order, Rotaceæ. Hyperica, Jussieu. Essential character; calyx five-leaved; petals five; nectary none; capsule one-celled, many-seeded. There is but one species; *viz.* B. juniperina, a shrub between heath and juniper, very branching and upright, the branches covered with leaves; leaves opposite, very much crowded, acerose, an inch long, acute, unarmed, evergreen; flowers terminating the branches, several together, sessile. It is found in New Granada.

BRAUNSPATH, *pearl-spar*, in mineralogy, is milk-white, though passing, by different shades, to the brownish red: it occurs generally crystallized, and the forms of its crystals are the same as certain varieties of calcareous spar. Its primitive figure is a rhomboid, exactly corresponding with that of calcareous spar. It is found of other figures, which are described particularly by Hauy. The external lustre is more or less shining with a pearly lustre; but, when in the first state of decomposition, it has usually a variegated semi-metallic appearance: it is a little harder than calcareous spar: the specific gravity, according to Brisson, is 2.83; but the Isabella yellow variety has been found to be only 2.4. Before the blowpipe it crackles and falls to pieces, and becomes of a brownish black colour, but does not melt; with borax it runs into a frothy flag; it effervesces with acids when pulverized. The massive variety, when calcined and mixed with sand, forms a strong and valuable cement, which sets quickly, and is impenetrable to water. The constituent parts are

Carbonate of lime......	50
Oxide of iron............	20
Oxide of manganese...	28
	100

It occurs chiefly in veins, accompanied by calcareous spar, galenablende, pyrites, and various ores of silver. It is found in the mines of Norway, Germany, Sweden, France, and in some parts of England and Wales.

BRAWN, the flesh of a boar souced or pickled; for which end the boar should be old; because the older he is, the more horny will the brawn be.

BRAZIL *wood*, in the arts. The tree which bears this wood is the cæsalpina crista. The wood is very hard, takes a high polish, and is so heavy as to sink in water. When chewed it gives a sweetish taste. It much resembles in appearance red saunders wood, but differs from it essentially in readily giving out its colour to water, which saunders wood does not.

Brazil wood is valuable for the beautiful orange and red colours, in various shades, which it furnishes to the dyer, but the colour is naturally very fugitive, though it may be to a certain degree fixed by various mordants. When raspings of brazil wood are boiled for some time in water, they give a fine red decoction. The residue appears black, but alkalies will continue to extract a colour from it after the action of water is exhausted. Spirit of wine and ammonia also extract a colour with great facility, which is somewhat deeper than the watery decoction. A decoction of brazil wood is readily turned of a violet or purple blue by alkalies, and this change is produced by so very minute a quantity as to furnish a chemical test of the presence of alkalies of very great utility. According to Bergmann, 10 grains of crystallized carbonate of soda, which contains no more than about 2.15 grains of mere alkali, dissolved in something more than 5.5 English pints of water, give a sensible purple tinge to paper reddened by brazil wood. There is, however, some ambiguity in this test, as the same change is produced by a solution of lime or magnesia in carbonic acid and water, a very frequent occurrence in most natural waters. Evaporating the water for some time will distinguish whether the change on brazil wood is produced by an alkali or a corbonated earth; for, if by the former, the purple will be more intense in the concentrated water, as it now holds a greater proportion of alkali; but if by a carbonated earth, the effect will be lost, as the boiling expels the loose carbonic acid, and precipitates the carbonated earth which it held in solution. The effects of the solutions of tin and alum on brazil wood are the most important to the dyer. Alum added to the watery decoction of the wood gives a copious fine red precipitate, inclining to crimson, and subsiding slowly. The supernatant liquor also retains the original red colour of the decoction, but if enough of alkali is added to decompose the alum, its earth falls down and carries with it nearly all the remaining colouring matter of the

wood. In this way a fine crimson lake, imitating the cochineal carmine, may be prepared, which therefore consists of alumine, intimately combined with the colouring matter of the wood a little heightened. Nitro-muriate of tin added to the decoction separates the whole of the colouring matter, which falls down in great abundance in union with the oxide of tin, and the liquor remains colourless.

The solutions of iron blacken the decoction or infusions of brazil wood, shewing the presence of the gallic acid. Many of the other metallic solutions act similarly to that of tin, in forming lakes, consisting of the colouring matter of the wood united with the metallic oxide of the solution employed. See Dyeing.

BRAZING, the soldering or joining two pieces of iron together by means of thin plates of brass, melted between the pieces that are to be joined. If the work be very fine, as when two leaves of a broken saw are to be brazed together, they cover it with pulverized borax, melted with water, that it may incorporate with the brass powder, which is added to it; the piece is then exposed to the fire without touching the coals, and heated till the brass is seen to run.

Brazing is also used for the joining two pieces of iron together by beating them hot, the one upon the other, which is used for large pieces by farriers; this is more properly welding.

BREACH, in fortification, a gap made in any part of the works of a town by the cannon or mines of the besiegers, in order to make an attack upon the place. To make the attack more difficult, the besieged sow the breach with crow-feet, or stop it with chevaux de frize. A practicable breach is that where the men may mount and make a lodgment, and ought to be fifteen or twenty fathoms wide. The besiegers make their way to it, by covering themselves with gabions, earth-bags, &c.

Breach, in a legal sense, is where a person breaks through the condition of a bond or covenant, on an action upon which, the breach must be assigned; and this assignment must not be general, but particular, as in an action of covenant for not repairing houses, it ought to be assigned particularly what is the want of reparation; and in such certain manner, that the defendant may take an issue.

BREAD is a light porous spongy substance, prepared by fermentation and baking from the flour of certain farinaceous seeds, especially wheat, and is the principal sustenance of man in the temperate regions of the northern hemisphere.

When flour is kneaded with water, it forms a tough paste, called dough, which, if kept in a warm place, swells, becomes spongy, and filled with a number of air-bubbles: in this state it is called leaven: and this leaven, if incorporated with fresh dough, will bring the whole into a fermenting state, much more speedily and uniformly than if the mass was exposed to spontaneous decomposition. But though leavened bread is perfect in every other respect, it always retains a slightly acidulous flavour from the leaven by which it is fermented; for it is impossible to carry the fermentation of the gluten to a sufficient extent to change in into leaven, without at the same time exciting the acid fermentation in the sugar of the flour. It was therefore a very important improvement in the art, and one which is attributable to the English bakers, to substitute yeast or the froth of malt-liquor in a state of fermentation to leaven; for the former not only communicates no unpleasant flavour to bread, but is also a more speedy ferment, and by acting first on the gluten of the flour produces the desired effect before any acid has time to be evolved from the other ingredients. The process of making common bread is extremely simple, though its perfect success depends considerably on a kind of knack in manipulation, which cannot be described by words. It is of essential consequence that the flour and yeast should be mixed together with perfect accuracy, in order that the whole mass may be equally fermented, and that this action may commence in every part at the same time. Now, though in the making of a single loaf this may easily be effected at one continued process, yet where a considerable quantity of bread is to be made at once, this is impracticable. See Baking.

The changes produced upon dough by baking are very remarkable, nor can they in any degree be attributed to evaporation, since the loss of weight never ought to exceed $\frac{1}{30}$, and is very often not greater than $\frac{1}{60}$. In the first place the progress of fermentation is entirely stopped: the bread may be kept for several days without experiencing any alteration, and the first sign of spontaneous change is its becoming mouldy. Secondly, the tenacious ductility of the dough and its compact texture are

exchanged for a moderately firm and slightly elastic consistence, and a very spongy texture, in consequence of the alterations produced in the gluten by heat and moisture. Thirdly, the fecula or starch which was merely diffused through the dough, without being in any degree affected by the pmary fermentation, is combined during the baking with a portion of water into a stiff jelly, like common starch when boiled with water, and thus renders the bread considerably more transparent than dough, as well as more digestible. Rye and barley are the only substances besides wheat that are capable of being made into bread, because they alone contain gluten enough to admit of being formed into a moderately tenacious paste with water. Even in these, however, the proportion of gluten is too small to afford light bread without the use of an acid ferment to disengage the proper quantity of carbonic acid; so that they can never for the purpose of the baker be at all comparable to wheaten flour.

Bread *fruit tree*. See Artocarpus.

Bread *nut tree*. See Brosimum.

Bread *room*, in a ship, that destined to hold the bread or biscuit. The boards of the bread room should be well joined and caulked, and even lined with tin plates or mats. It is also proper to warm it well with charcoal for several days before the biscuit is put into it; since nothing is more injurious to the bread than moisture.

BREADTH, in geometry, one of the three dimensions of bodies, which, multiplied into their length, constitutes a surface.

BREAKERS, in maritime affairs, a name given to those billows that break violently over rocks lying under the surface of the sea. They are easily distinguished both by their appearance and sound, as they cover that part of the sea with a perpetual foam, and produce a hoarse and terrible roaring, very different from what the waves usually have in a deeper bottom. When a ship is driven among breakers it is hardly possible to save her, as every billow that heaves upwards serves to dash her down with additional force, when it breaks over the rocks or sands beneath.

BREAKING, in a mercantile stile, denotes the not paying one's bills of exchange accepted, or other promissory notes, when due; and absconding to avoid the severity of one's creditors. In which sense breaking is the same thing with becoming bankrupt. See Bankrupt.

Breaking *bulk*, in the sea language, is the same with unlading part of the cargo.

BREAMING, in maritime affairs, burnoff the filth, such as grass, ooze, shells, or sea-weed, from the ship's bottom, which it has contracted by lying long in the harbour: it is performed by holding kindled furze, faggots, &c. which by melting the pitch that formerly covered it, loosens whatever filth may have adhered to the planks. The bottom is then covered anew. This operation may be performed either by laying the ship aground after the tide has ebbed from her, or by docking, or careening. See Careening.

BREAST, in anatomy, denotes the forepart of the thorax. See Anatomy.

Breasts, two glandulous tumours, of a roundish oval figure, situated on the anterior, and a little towards the lateral parts of the thorax. See Anatomy.

Breast *work*, in military affairs, is an elevation thrown up around a fortified place, to conceal or protect the garrison, and which is at the same time so strong that the enemies' shot cannot pierce it. The terms breast work and parapet are frequently used without any distinction, but the former is more applicable in a general sense; a parapet implying more immediately that breast work which is raised upon the rampart of a fortified town.

BRECCIA, a term employed by Italian statuaries to denote those kinds of marble which are really or apparently composed of angular fragments of marble, cemented together by a posterior infiltration of calcareous spar or marble. The French have adopted the term, and extended its meaning so as to include any strong mass composed of angular fragments consolidated by a cement. Hence they subdivide the term breche into calcareous, magnesian, silicious, and argillaceous, taking care to discriminate it from amygdaloid or pondingere, (from the English pudding stone) by restricting the meaning of this latter to stony masses, formed of rounded pebbles, imbedded in a cement.

BREDEMEYERA, in botany, a genus of the Diadelphia Octandria: calyx three-leaved; corolla papilionaceous; banner two-leaved; drupe with a two-celled nut. One species, *viz*. B. foribunda.

BREECH, of a gun, the distance from the hind part of the base ring to the beginning of the bore, and is always equal to the thickness of the metal at the vent.

BREECHINGS, in the sea language, the

ropes with which the great guns are lashed or fastened to the ship's side. They are thus called because made to pass round the breech of the gun.

BREEZE, a shifting wind, that blows from sea or land for some certain hours of the day or night; common in Africa, and some parts of the East and West Indies. The sea breeze is only sensible near the coasts; it commonly rises in the morning about nine, proceeding slowly in a fine small black curl on the water, towards the shore; it increases gradually till twelve, and dies about five. Upon its ceasing, the land breeze commences, which increases till twelve at night, and is succeeded in the morning by the sea breeze again.

BREEZE, in brick-making, small ashes and cinders, sometimes made use of instead of coals for the burning of bricks.

BRENTUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ moniliform, inserted beyond the middle of the snout; head projecting into a very long, straight, cylindrical snout. There are eleven species in two divisions; A. thighs simple; B. thighs toothed. B. bifrons is black; shells striate with glabrous yellow spots: it inhabits Cayenne. In one sex the snout is cylindrical, black; antennæ short; thorax purplish, with three black lines: in the other sex the snout is projected, cylindrical, thickened at the tip with incurved jaws; thorax caniculate, black.

BREVE, in music, a note or character of time, in the form of a diamond or square, without any tail, and equivalent to two measures, or minims.

BREVE, or BREVIS, in grammar: syllables are distinguished into longs and breves, according as they are pronounced quicker or more slow.

BREVET *rank*, is a rank in the army higher than that for which a person receives pay. It gives precedence when corps are brigaded, according to the date of the brevet commission.

BREVIARY, a daily office, or book of divine service in the Romish church. It is composed of matins, lauds, first, third, sixth, and ninth vespers, and the compline or post communio.

The breviary of Rome is general, and may be used in all places; but on the model of this various others have been built, appropriated to each diocese, and each order of religious.

BREWER, a person who professes the art of brewing. There are companies of brewers in most capital cities: that of London was incorporated in 1427, by Henry VI. and that of Paris is still older.

BREWING, the art of brewing, or of preparing a vinous fermented liquor from the farinaceous seeds, is of very high antiquity. The ancient Egyptians, from the soil and climate of their country not being favourable to the culture of the vine, were induced to seek a substitute in barley, from which, in all probability, by the process of malting, they knew how to procure a fermented liquor. All the ancient malt liquors, however, seem to have been made entirely of barley, or some other farinaceous grain, and therefore were not generally calculated for long keeping, as this quality depends considerably, though not entirely, on the bitter extract of hops, or other vegetables, with which the liquor is mingled. Modern malt liquor is essentially composed of water, of the soluble parts of malt and hops, and of yeast.

Three or four different kinds of malt are distinguished by the brewer by their colours, which depend on the degree of heat that is used in the drying. Malt that has been dried by a very gentle heat scarcely differs in its colour from barley; if exposed to a somewhat higher temperature, it acquires a light amber-yellow hue; and by successive increments of heat, the colour becomes deeper and deeper, till, at length, it is black. The change of colour is owing to the grain being partially charred or decomposed; and in proportion to the extent to which this alteration is allowed to proceed, will the produce of sugar, that is, of fermentable matter, be diminished. The principal advantage of high-dried malt over the paler kind, is the deep yellowish brown tinge which it gives to the liquor; but this colour may be communicated much more economically by burnt sugar. The malt, whether pale or high-dried, must be bruised between rollers, or coarsely ground in a mill before it is used, and it is found by experience, that malt which has lain to cool for some weeks is, in many respects, preferable to that which is used, as it comes hot from the mill. The first step in the process of brewing, is

Mashing. This is performed in the mash-tub, which is a circular wooden vessel, shallow in proportion to its extent, and furnished with a false bottom pierced with small holes, fixed a few inches above the real bottom: when it is small it

ought to have a moveable wooden cover. There are two side openings in the interval between the real and false bottoms; to one is fixed a pipe, for the purpose of conveying water into the tun; the other is fitted with a spigot, for the purpose of drawing the liquor out of the tun. The brewing commences by strewing the grist or bruised malt evenly over the false bottom of the mash-tun, and then, by means of the side pipe, letting in from the upper copper the proper quantity of hot water. The water first fills the interval between the two bottoms, then, forcing its way through the holes in the false bottom, it soaks into the grist, which, at first floating on the surface of the water, is thus raised off the bottom on which it was spread. When the whole of the water is let in, the process of mashing, properly so called, begins. The object in mashing, is to effect a perfect mixture of the malt with the water, in order that all the soluble parts may be extracted by this fluid: for this purpose, the grist is first incorporated with the water by means of iron rakes, and then the mass is beaten and agitated, and still further mixed by long flat wooden poles, resembling oars, which indeed is the name by which they are technically known. In some of the large porter breweries, the extent of the tun is so great, that the process of mashing cannot be adequately performed by human labour, and recourse is had to a very simple and effectual instrument for this purpose. A very strong iron screw, of the same height as the mash-tun, is fixed in the centre of this vessel, from which proceed two great arms or radii, also of iron, and beset with vertical iron teeth a few inches asunder, in the manner of a double comb; by means of a steam engine, or any other moving power, the iron arms, which at first rest on the false bottom, are made slowly to revolve upon the central screw, in consequence of which, in proportion as they revolve, they also ascend through the contents of the tun to the surface; then, inverting the circular motion, they descend again in the course of a few revolutions to the bottom. These alternate motions are continued till the grist and water are thoroughly incorporated. When the mashing is completed, the tun is covered in to prevent the escape of the heat, and the whole is suffered to remain still, in order that the insoluble parts may separate from the liquor: the side spigot is then withdrawn, and the clear wort is allowed to run off, slowly at first, but more rapidly as it becomes fine, into the lower or boiling copper. The principal thing to be attended to, is the temperature of the mash, which depends, partly on the heat of the water, and partly on the state of the malt. If any quantity of barley is mingled with twice its bulk of water, the temperature of the mass will be very nearly that of the mean temperature of the ingredients. If the palest malt is subjected to the same experiment, the temperature will be somewhat greater than that of the mean heat. The most eligible temperature upon the whole for mashing, appears to be about 185° to 190° of Fahrenheit: the heat of the water, therefore, for the first mashing, must be somewhat below this temperature, and the lower in proportion to the dark colour of the malt made use of. Thus, for pale malt, the water of the mash may be at 180° and upwards; but for high-dried brown malt, it ought not much to exceed 170°.

The wort of the first mashing is always by much the richest in saccharine matter; but to exhaust the malt, a second and third mashing is required; and as no heat is generated, except in the first mashing, the water in the succeeding ones may be safely raised to nearly 190°. The proportion of wort to be obtained from each bushel of malt depends entirely on the proposed strength of the liquor. For sound small beer, thirty gallons of wort may be taken from each bushel of malt; but for the strongest ale, only the produce of the first mashing, or about six and a half gallons per bushel, is employed. But whatever be the proportion of wort required, it must be held in mind, that every bushel of well made malt will absorb and retain three and three-quarters gallons of water, and, therefore the water made use of must exceed the wort required, in the same proportion.

Boiling and hopping. If only one kind of liquor (whether ale or beer) is to be made, the produce of the three mashings is to be mixed together; but if both ale and beer are required, the wort of the first, or of the first and second mashings, is appropriated to the ale, and the remainder is set aside for the beer. All the wort destined for the same liquor, after it has run from the mashtun, is transferred to the large lower copper, and mixed while it is heating with the required proportion of hops. The stronger the wort is, the larger proportion of hops does it demand: and this is calculated in two ways, either according to the quantity of malt em-

ployed, or the richness of the wort. Where the former basis of calculation is referred to, the quantity of hops, especially in private families, where economy is not so strictly attended to as in large establishments, is one pound of hops to a bushel of malt, whether the wort is intended for the strongest ale, or the weakest small beer. In public breweries, the proportion of hops is considerably smaller, and is regulated, not merely by the quantity of malt, but the richness of the wort. For strong ales, the common proportion is about one pound of hops to 1.3 bushel of malt; for beer, the quantity is lowered to one pound of hops to 1.7 bushel of malt. When both ale and beer are brewed from the same malt, the usual practice is to put the whole quantity of hops in the ale wort; and after they have been boiled a sufficient time in this, to transfer them to the beer-wort, in order to be exhausted by a second boiling. When the hops are mixed with the wort in the copper, the liquor is brought to boil; and the best practice is to keep it boiling as fast as possible, till, upon taking a little of the liquor out, it is found to be full of minute flakes, like curdled soap. These flakes consist of the gluten and starch of the malt separated from their former solution in the wort, by the joint action, in all probability, of the heat, and the bitter extract of the hops.

Cooling. When the liquor is sufficiently boiled, it is discharged into a number of shallow tubs called coolers, where it remains exposed to a free draft of air, till it has deposited the hop seeds and coagulated flakes with which it was charged, and is become sufficiently cool to be submitted to the next process, which is that of fermentation. It is necessary that the process of cooling should be carried on as expeditiously as possible, particularly in hot weather; for unfermented wort, by exposure to a hot close air for a few hours, is very liable to contract a nauseous smell and taste, when it is said technically to be foxed, in consequence of small spots of white mould forming on its surface. Liquor made from pale malt, and which is intended for immediate drinking, need not be cooled lower than 75° or 80°, and, in consequence, may be made all the year through, except, perhaps, during the very hottest season; but beer from brown malt, especially if intended for long keeping, requires to be cooled to 65° or 70°, and therefore cannot possibly be made, except in cool weather; hence it is, that the months of March and October have always been reckoned peculiarly favourable to the manufacture of the best malt liquor.

Tunning and barrelling. From the coolers, the liquor is transferred into the fermenting or working tun, which is a large cubical wooden vessel, capable of being closed at pleasure. As soon as the wort is let in, it is well mixed with yeast, in the proportion of about one gallon to four barrels, and in about five hours afterwards the fermentation commences. When the wort is let down hot into the working tun, the fermentation is conducted with the tun closed, and proceeds rapidly, so that in about eighteen or twenty hours it is fit to be cleansed or put into the barrels; but when the wort is let down at 65°, it requires forty-eight hours for the first fermentation, and is peculiarly liable to be affected by a considerable change of weather.

The last process is transferring the liquor from the working tun to the barrels, when the fermentation is completed. During a few days, a copious discharge of yeast takes place from the bung-hole, and the barrels must be carefully filled up every day with fresh liquor: this discharge gradually becomes less, and in about a week ceases; at which time the bung-hole is closed up, and the liquor is fit for use, after standing from a fortnight to three months, according to its strength, and the temperature at which it has been fermented.

BREYNIA, in botany, so named in memory of Jacob Breynius and his son, both famous botanists, a genus of the Polygamia Dioecia class and order. Essential character: calyx one-leafed; corolla none: Herm. calyx six-parted; anthers five, linear, fastened to the style; berry three-celled; seeds two. Male, calyx five-parted; filaments five; anthers roundish. Female, stigmas five, obcordate, petalloid, without any style: capsule five-celled; seed solitary. There is but one species, *viz.* B. disticha, a native of New Caledonia, and the Isle of Tanna in the South Seas.

BRIBERY, in common law, is when a person, occupying a judicial place, takes any fee, gift, reward, or brocage, for doing his office, or by colour of his office, except of the king only. In a larger sense, bribery denotes the receiving or offering of any undue reward, to or by any person concerned in the administration of public justice, as an inducement for acting contrary to duty; and sometimes it signifies

the taking or giving of a reward for a public office. In England, this offence of taking bribes is punished, in inferior officers, with fine and imprisonment; and in those who offer a bribe, though not taken, the same. But in judges, especially the superior ones, it has always been regarded as a very heinous offence; insomuch that anciently it was punished as high treason, and the chief justice Thorp was hanged for it in the reign of Edward III. and at this day it is punishable with forfeiture of office, fine, and imprisonment. Officers of the customs taking any bribe, whereby the crown may be defrauded, forfeit 100*l.* and are rendered incapable of any office; and the person giving the bribe, or offering any bribe to officers of the customs, to induce them to connive at the running of goods, shall forfeit 50*l.* Candidates that bribe electors, after the date or teste of the writs, or after the vacancy, by giving or promising any money or entertainment, are disabled to serve for that place in parliament; and he that takes as well as he that offers a bribe forfeits 500*l.* and is for ever disabled from voting, and holding any office in any corporation, unless, before conviction, he discovers some other offender of the same kind, whereby he is indemnified for his own offence.

BRICK, a well-known substance, four inches broad, and eight or nine long, made by means of a wooden mould, and then baked or burnt in a kiln, to serve the purposes of building.

Bricks are of great antiquity, as appears by the sacred writings, the tower and walls of Babylon being built with them. In the east they baked their bricks in the sun; the Romans used them unburnt, only leaving them to dry for four or five years in the air.

The general process of the manufacture of bricks here is as follows: the earth should be dug in the autumn; it should lie during the whole of the winter exposed to the frost, as the action of the air, in penetrating and dividing the particles of the earth, facilitates the subsequent operations of mixing and tempering. During this time the earth should be repeatedly turned and worked with the spade. In the spring the clay is broken in pieces and thrown into shallow pits, where it is watered and suffered to remain soaking for several days. The next step is that of tempering the clay, which is generally performed by the treading of men or oxen. In the neighbourhood of London, however, this operation is performed by means of a horse-mill. The tempering of the clay is the most laborious part of the process, and that on which the perfection of the manufacture essentially depends. It is to neglect in this part that we are chiefly to attribute the bad quality of modern bricks, in comparison with the ancient. All the stones should be removed and the clay brought to a perfectly homogeneous paste, using the least possible quantity of water. The earth, being sufficiently prepared in the pits, is brought to the bench of the moulder, who works the clay into the brick-moulds and strikes off the superfluous earth. The bricks are delivered from the mould and ranged on the ground; and when they have acquired a sufficient hardness to admit of handling they are dressed with a knife, and stacked or built up in long dwarf walls, and thatched over, where they remain to dry.

The method of burning bricks. Bricks are burnt either in a kiln or clamp. Those that are burnt in a kiln, are first set or placed in it, and then the kiln being covered with pieces of bricks, they put in some wood, to dry them with a gentle fire; and this they continue till the bricks are pretty dry, which is very easily known by those accustomed to the business: they then leave off putting in wood, and proceed to make ready for burning, which is performed by putting in brush, furze, spray, heath, brake, or fern faggots; but before they put in any faggots, they dam up the mouth or mouths of the kiln with pieces of bricks, piled up one upon another, and close it up with wet brick-earth, instead of mortar; then they proceed to put in more faggots, till the kiln and its arches look white, and the fire appears at the top of the kiln; upon which they slacken the fire for an hour, and let all cool by degrees. This they continue to do, alternately heating and slaking, till the ware be thoroughly burnt, which is usually effected in forty-eight hours.

About London they chiefly burn in clamps, built of the bricks themselves, after the manner of arches in kilns, with a vacancy between each brick, for the fire to play through; but with this difference, that instead of arching, they span it over by making the bricks project one over another, on both sides of the place, for the wood and coals to lie in till they meet, and are bounded by the bricks at the top, which close all up. The place for the fuel is

carried up straight on both sides, till about three feet high; then they almost fill it with wood, and over that lay a covering of sea-coal, and then overspan the arch; but they strew sea-coal also over the clamp, betwixt all the rows of bricks; lastly, they kindle the wood, which gives fire to the coal, and when all is burnt, then they conclude the bricks are sufficiently burnt.

The different kinds of bricks made in this country are principally place bricks, grey and red stocks, marl facing bricks, and cutting bricks. The place bricks and stocks are used in common walling; the marls are made in the neighbourhood of London, and used in the outside of buildings; these are very beautiful bricks, of a fine yellow colour, hard, and well burnt, and in every respect superior to the stocks. The finest kind of marl and red bricks are called cutting bricks, they are used in the arches over windows and doors, being rubbed to a centre, and gauged to a height. There is also a fine kind of white bricks made near Ipswich, which are used for facing, and sometimes brought to London for that purpose. The Windsor bricks, or fire bricks, which are made at Hedgerly, a village near Windsor, are red bricks, containing a very large proportion of sand; these are used for coating furnaces, and lining the ovens of glass-houses, where they stand the utmost fury of the fire. Dutch clinkers are also imported, long narrow bricks of a brimstone colour, very hard and well burnt; they are frequently warped, and appear almost vitrified by the heat.

BRICKLAYER, one who lays bricks in the building of edifices of any kind. Tilers and bricklayers were incorporated 10 Elizabeth, under the name of master and wardens of the society of freedom of the mystery and art of tilers and bricklayers. The materials used by bricklayers, are bricks, tiles, mortar, laths, nails, and tile-pins. Their tools are, a brick-trowel, wherewith to take up mortar; a brick-axe, to cut bricks to the determined shape; a saw, for sawing bricks; a rub-stone, on which to rub them; also a square, wherewith to lay the bed or bottom, and face or surface of the brick, to see whether they be at right angles; a bevel, by which to cut the under sizes of bricks to the angles required; a small trannel of iron, wherewith to mark the bricks; a float-stone, with which to rub a moulding of brick to the pattern described; a banker, to cut the bricks on; line-pins, to lay their rows or courses by; plumb-rule, whereby to carry their work upright; level, to conduct it horizontal; square, to set off right angles; ten-foot rod, with which to take dimensions; jointer, wherewith to run the long joints; rammer, with which to beat the foundation; crow and pick-axe, wherewith to dig through walls.

BRIDEWELL, in Bridge street, Blackfriars, a singular foundation, comprising within the same walls, an hospital, a workhouse, and a prison. Edward VI. founded this place, which had formerly been one of King John's palaces. Several manufacturers reside there, who have the privilege of taking apprentices. When these have served faithfully the period of their servitude, they have a title to the freedom of the city, and ten pounds to assist them in the world.

BRIDGE, a work of masonry or timber, consisting of one or more arches, built over a river, canal, or the like, for the convenience of crossing the same. Bridges are a sort of edifices very difficult to execute, on account of the inconvenience of laying foundations, and walling under water.

The parts of a bridge are the piers, the arches, the pavement, or way over for cattle and carriages, the foot way on each side for foot passengers, the rail or parapet which incloses the whole, and the butments or ends of the bridge on the bank.

The conditions required in a bridge are, that it be well designed, commodious, durable, and suitably decorated. The piers of stone bridges should be equal in number, that there may be one arch in the middle, where commonly the current is strongest; their thickness is not to be less than a sixth part of the span of the arch, nor more than a fourth; they are commonly guarded in the front with angular sterlings, to break the force of the current: the strongest arches are those whose sweep is a whole semicircle; as the piers of bridges always diminish the bed of a river, in case of inundations, the bed must be sunk or hollowed in proportion to the space taken up by the piers (as the waters gain in depth what they lose in breadth), otherwise the current may wash away the foundation, and endanger the piers: to prevent this, they sometimes diminish the current, either by lengthening its course, or by making it more winding; or by stopping the bottom with rows of planks, stakes, or piles, which break the current. It is also required, that the foundation of bridges be laid at that season of the year when the waters are

lowest; and if the ground be rocky, hard gravel, or stony, the first stones of the foundation may be laid on the surface; but if the soil be soft sand, it will be necessary to dig till you come to a firm bottom. For the particular mode of constructing stone bridges, the reader is referred to the latter end of the article BUILDING.

We have many bridges of considerable note in our own country. The triangular bridge at Croyland, in Lincolnshire, which was erected about the year 860, is said to be the most ancient Gothic structure remaining entire in the kingdom. There are two circumstances in the constructon of this bridge which render it an object of great curiosity. First, it is formed by three semi-arches, whose bases stand in the circumference of a circle, at equal distances from each other. These unite at the top; and the triune nature of the structure has led some to imagine that it was intended as an emblem of the Trinity. Secondly, the ascent on each of the semi-arches is by steps paved with small stones set edgeways, and is so steep, that none but foot-passengers can go over the bridge: horsemen and carriages frequently pass under it, as the river in that place is but shallow. For what purpose this bridge was really designed, it is difficult, if not impossible, to determine. Utility, it is obvious, was one of the least motives to its erection. To boldness of design and singularity of construction it has more powerful claims; and these qualities it must be allowed to possess, in as great a degree as any bridge in Europe. Although this bridge has been erected so many centuries, it exhibits no marks of decay.

London bridge is in the old Gothic style, and had twenty small locks or arches; but there are now only nineteen open, two having been lately thrown into one in the centre. It is 940 feet long, 44 high, and 47 clear width between the parapets. The piers are from 15 to 35 feet thick, with starlings projecting at each side and end, so that the greatest water-way, when the tide is above the starlings, is 545 feet, scarcely half the breadth of the river; and below the starlings the water-way is reduced to 204 feet, causing a dangerous fall at low water. London bridge was first built with timber in the reign of Ethelred, between the years 993 and 1016; it was repaired, or rather rebuilt, of timber in 1163, and the present stone bridge was begun under King Henry II. in 1176, and finished under King John in the year 1209. It is probable there were no houses on the bridge for upwards of 200 years, since we read of a tilt and tournament held on it in 1395. Houses were erected upon it afterwards, but being found a great inconvenience and nuisance, they were removed in 1758, the avenues to the bridge enlarged, and the whole made more commodious: the two middle arches were then thrown into one, by removing the pier from between them. The expense of the repairs amounted to above 80,000*l.*

The bridges of Westminster and Blackfriars, over the river Thames at London, are among the finest structures of the kind in Europe. The former is 1220 feet long, and 44 feet wide, having a commodious broad foot-path on each side for passengers. It consists of thirteen large and two small arches, fourteen intermediate piers, and two abutments. The length of each abutment is 76 feet; the opening of each of the smaller arches is 25 feet; the span of the first of the large arches at each end is 52 feet, of the next 56 feet, and so on, increasing by four feet at a time to the centre arch, the span of which is 76 feet. The two piers of the middle arch are 17 feet wide, and the others decrease equally on each side, by one foot at a time, every pier terminating with a salient right angle against either stream. The arches are semi-circular, and spring from about the height of two feet above low water. The breadth of the river in this place is about 1220 feet, and the water-way through the bridge amounts to 870 feet. The bridge was begun in 1738, and opened for passengers in 1750, at a neat expense of 218,800*l.* It is constructed of the best materials, and in a neat and elegant taste; but the arches are too small in proportion to the quantity of masonry.

Blackfriars bridge, nearly opposite to the centre of the city of London, was begun in 1760, and completed in ten years and three quarters, at a neat expense of 152,840*l.* It is an exceedingly light and elegant structure; but, unfortunately, the materials do not seem to be of the best kind, as many of the stones in the piers are decayed. The bridge consists of nine large, handsome, and nearly elliptical arches; the central arch is 100 feet wide, and the four arches on each side, reckoning towards the shores, decrease gradually, being 98, 93, 83, and 70 feet respectively, leaving a water-way of 788 feet. The whole length from wharf to wharf is 995 feet, the breadth of the carriage-way 28 feet, and that of the

raised foot-way on each side 7 feet. The upper surface of the bridge is a portion of a very large circle, which forms an elegant figure, and admits of convenient passage over it. On each pier there is a recess or balcony, with two Ionic columns and pilasters, which stand on a circular projection of the pier above high-water mark. The bridge is rounded off at each extremity to the right and left, in the form of a quadrant of a circle, rendering the access commodious and agreeable. This edifice must be regarded as a fine specimen of Mr. Mylne's ingenuity and judgment, though the method of construction has never been made public.

Wooden bridges now demand our attention. The simplest case of these edifices is that in which the road-way is laid over beams placed horizontally, and supported at each end by piers or posts. This method, however, is deficient in strength and width of opening: it is, therefore, necessary, in all works of any magnitude, to apply the principles of trussing, as used in roofs and arches. Wooden bridges of this kind are stiff frames of carpentry, in which, by a proper disposition, beams are put so as to stand in place of solid bodies, as large as the spaces which the beams enclose; and thus, two or three, or more, of these are set in a butment with each other, like mighty arch stones. At Schaffhausen, in Switzerland, where the Rhine flows with great rapidity, several stone bridges had been destroyed, when, in 1754, Grubenhamm offered to throw a wooden bridge of a single arch across the river, which is nearly 390 feet wide. The magistrates, however, required that it should consist of two arches, and that he should, for that purpose, employ the middle pier of the last stone bridge, which would divide the new one into two unequal arches of 172 and 193 feet span. The carpenter did so; but contrived to leave it a matter of doubt, whether the bridge is at all supported by the middle pier. It was erected on a plan nearly similar to the Wittengen bridge, at the expense of about 8,000*l.* sterling. Travellers inform us, that it shook if a man passed over it; yet waggons, heavily laden, also went over it without danger. This curious bridge was burnt by the French when they evacuated Schaffhausen, in April, 1799.

Iron bridges are the exclusive invention of British artists. The first that has been erected on a large scale is that over the river Severn, at Coalbrook Dale, in Shropshire. This bridge is composed of five ribs, and each rib of three concentric arcs, connected together by radiating pieces. The interior arc forms a complete semicircle, but the others extend only to the cills under the road-way. These arcs pass through an upright frame of iron, at each end, which serves as a guide; and the small space in the haunches between the frames and the outer arc is filled in with a ring of about seven feet diameter. Upon the top of the ribs are laid cast iron plates, which sustain the road-way. The arch of this bridge is 100 feet 6 inches in span; the interior ring is cast in two pieces, each piece being about 70 feet in length. It was constructed in the year 1779, by Mr. Abraham Darby, iron-master at Coalbrook Dale, and must be considered as a very bold effort in the first instance of adopting a new material. The total weight of the metal is 378½ tons.

The second iron bridge, of which the particulars have come to our knowledge, was that designed by Mr. Thomas Paine, author of many political works. It was constructed by Messrs. Walkers, at Rotherham, and was brought to London, and set up in a bowling-green at Paddington, where it was exhibited for some time. After which it was intended to have been sent to America; but Mr. Paine not being able to defray the expense, the manufacturers took it back, and the malleable iron was afterwards worked up in the construction of the bridge at Wearmouth.

The third iron bridge of importance erected in Great Britain was that over the river Wear, at Bishop Wearmouth, near Sunderland, the chief projector of which was Rowland Burdon, Esq. M. P. This bridge consists of a single arch, whose span is 236 feet; and as the springing stones at each side project two feet, the whole opening is 240 feet. The arch is a segment of a circle, of about 444 feet diameter, its versed sine is 34 feet, and the whole height from low water about 100 feet, admitting vessels of from two to three hundred tons burthen to pass under, without striking their masts. A series of one hundred and five blocks form a rib, and six of these ribs compose the breadth of the bridge. The spandrils, or the spaces between the arch and the road-way, are filled up by cast iron circles, which touch the outer circumference of the arch, and at the same time support the road-way, thus gradually diminish-

ing from the abutments towards the centre of the bridge. There are also diagonal iron bars, which are laid on the tops of the ribs, and extended to the abutments to keep the ribs from twisting. The superstructure is a strong frame of timber, planked over to support the carriage-road, which is composed of marl, lime-stone, and gravel, with a cement of tar and chalk immediately upon the planks, to preserve them. The whole width of the bridge is 32 feet. The abutments are masses of almost solid masonry, 24 feet in thickness, 42 in breadth at bottom, and 37 at top. The south pier is founded on the solid rock, and rises from about 22 feet above the bed of the river. On the north side the ground was not so favourable, so that it was necessary to carry the foundation 10 feet below the bed. The weight of the iron in this extraordinary fabric amounts to 260 tons; 46 of these are malleable, and 214 cast. The entire expense was 27,000*l.*

The splendid example of the bridge at Wearmouth gave an impulse to public taste, and caused an emulation among artists, which has produced many examples, and more projects of iron bridges. The Coal-brook Dale Company have constructed several, among which is a very neat one over the river Parrot, at Bridgewater. Mr. Wilson, the engineer, employed by Mr. Burdon, has also built several, and some years since finished a very elegant one over the river Thames, at Staines, which is by far the most complete in design, as well as the best executed, of any that has hitherto been erected. This bridge consists of a single arch, 181 feet in span, and 16 feet 6 inches in rise, being a segment of a circle of 480 feet. The blocks, of which the ribs are composed, are similar to those in the Wearmouth bridge, except that these have only two concentric arcs instead of three, as at the latter. The arcs are cast hollow, and the block connected by means of dowels and keys; thus obviating the great defect observed at Wearmouth, of having so much hammered iron exposed to the action of the air. Four ribs form the width of the arch, which are connected together by cross frames. The spandrels is filled in with circles, which support a covering of iron plates an inch thick: on this is laid the roadway 27 feet wide. Two hundred and seventy tons is the weight of the iron employed in the bridge, and three hundred and thirty of the road-way.

Public bridges, which are of general conveniency, are of common right to be repaired by the inhabitants of that county in which they lie. Where a man makes a bridge for the common good of the King's subjects, he is not bound to repair it. No one can be compelled to build, or contribute to the charges of building any new bridge, without act of parliament: and if none are bounden to repair by tenure of prescription at common law, then the whole county or franchise shall repair it.

Bridges, *pendent or hanging*, called also philosophical bridges, are those not supported by posts or pillars, but hung at large in the air, sustained only at the two ends or butments.

Bridge, *draw*, one that is fastened with hinges at one end only, so that the other may be drawn up; in which case the bridge stands upright, to hinder the passage of a ditch or moat.

Bridge, *flying or floating*, is generally made of two small bridges, laid one over the other in such a manner, that the uppermost stretches and runs out, by help of certain cords, running through pullies placed along the sides of the under bridge, which push it forwards, till the end of it joins the place it is intended to be fixed on.

Bridge *of boats*, boats made of copper, and joined side by side, till they reach across a river, which being covered with planks, are fastened with stakes or anchors.

Bridge *of communication*, is that made over a river, by which two armies, or forts, which are separated by that river, have a free communication with one another.

Bridge, *floating*, a bridge made use of, in form of a work in fortification, called a redoubt, consisting of two boats, covered with planks, which are solidly framed, so as to bear either horse or cannon.

Bridge, in gunnery, the two pieces of timber which go between the two transums of a gun-carriage, on which the bed rest.

Bridge, in music, a term for that part of a stringed instrument over which the strings are stretched. The bridge of a violin is about one inch and a quarter high, and near an inch and a half long.

BRIEF, in common-law, a writ whereby a man is summoned or attached to answer any action. It is called brief, because it is couched in a few words, without any preamble. Brief is also used for a writing issued out of any of the king's courts of record at Westminster, whereby something is commanded to be done, in order to justice, or the execution of the king's command.

Brief is also taken for a letter patent, granting a licence to a subject to make collection for any public or private loss, as briefs for loss by fire, to be read by ministers in churches, &c. These briefs must be read in all churches and chapels, within two months after receipt thereof; and the sums thereby collected shall be paid over to the undertaker of briefs, within six months after the delivery of the briefs, under penalty of *20l.*

Brief is likewise an abridgement of a client's case, wrote out for the instruction of counsel, on a trial at law.

Briefs, *apostolical*, letters which the pope dispatches to princes, or other magistrates, relating to any public affair. These briefs are distinguished from bulls, in this respect the latter are more ample, and always written on parchment, and sealed with lead or green wax; whereas briefs are very concise, written on paper, sealed with red wax, and with the seal of the fisherman, or St. Peter in a boat.

BRIG. See **Brigantine.**

BRIGADE, in the military art, a party or division of a body of soldiers, whether horse or foot, under the command of a brigadier. An army is divided into brigades of horse and brigades of foot: a brigade of horse is a body of eight or ten squadrons; a brigade of foot consists of four, five, or six battalions. The eldest brigade has the right of the first line, and the second the right of the second, and the two next take the left of the two lines, and the youngest stand in the centre.

Brigade *major* is an officer appointed by the brigadier, to assist him in the management and ordering of his brigade.

BRIGADIER is the general officer who has the command of a brigade. The eldest colonels are generally advanced to this post. He that is upon duty is brigadier of the day. They march at the head of their own brigades, and are allowed a serjeant and ten men, of their own brigade for their guard.

BRIGANTINE, a small light vessel, which can both row and sail well, and is either for fighting or giving chace. It has about twelve or fifteen benches for the rowers, one man to a bench: all the hands aboard are soldiers, and each man has his musquet lying ready under his oar.

BRIGGS (**Henry**), in biography, a very considerable mathematician, born near Halifax, Yorkshire, in 1656; and in 1579 having attained a good share of gramatical knowledge, he went to St. John's College, Cambridge, where he took his degrees in regular order, and in 1588 was chosen fellow of his college. The bent of his mind was to the mathematics, in which he made so great and rapid a progress, that in 1592 he was appointed examiner and lecturer in that branch of science. In 1596 he was elected to the first professorship of geometry at Gresham College; he constructed a table for finding the latitude, from the variation of the magnetic needle being given. About the year 1609 he contracted an acquaintance with Mr. Usher, afterwards Archbishop of Armagh, and in correspondence with him, he mentions his employment upon the calculation of eclipses, and soon after writes that he is wholly engaged about the noble invention of logarithms, which had just made their appearance, and in the improvement of which he afterwards had so great a concern. On this subject he delivered various lectures at Gresham College, and proposed to alter the scale from the hyperbolic form which Napier had given them, to that in which 1 should be the logarithm of the ratio of 10 to 1. In 1616 Briggs made a visit to Napier at Edinburgh, and communicated to him his wishes. The alteration was agreed upon, and in 1617 he published his first 1000 of logarithms. He succeeded in 1619 to the Savilian professorship of geometry at Oxford, upon which he resigned the duties of Gresham College. Here he devoted himself most sedulously to his studies, and published many works connected with the higher branches of mathematics. His "Arithmetica Logarithmica" was printed in 1624; it contained the logarithms of 30,000 natural numbers to 14 places of figures, besides the index. He completed a table of logarithmic sines and tangents for the 100th part of every degree to 14 places; with a table of natural sines, tangents, and secants, with the construction of the whole. These tables were printed under the title of Trigonometria Britannica. "In the construction of these two works," says one of Mr. Briggs's biographers, "on the Logarithms of Numbers, and of Sines and Tangents, our author, besides extreme labour and application, manifests the highest powers of genius and invention; as we here for the first time meet with several of the most important discoveries in the mathematics, and what have hitherto been considered as of much later invention; such as the Binomial Theorem; the Differential Method and Con-

struction of Tables by Differences; the Interpolation of Differences, with Angular Sections, and several other ingenious compositions."

This great man died at Oxford in 1630, and was buried in the Chapel of Merton College, highly respected by his contemporaries, by many of whom his character was drawn with great ability: by Oughtred he is designated as the mirror of the age for his great skill in geometry: the learned Barrow extols his ability, skill, and industry, particularly in perfecting the invention of logarithms, which without his care, might have continued an imperfect and useless design. Dr. Smith represents him as easy of access to all, free from arrogance, moroseness, envy, ambition, and avarice, a contemner of riches, and contented in his own situation; preferring a studious retirement to all the splendid circumstances of life.

BRIMSTONE. See SULPHUR. Casts of medals have been taken off on a composition of which the chief ingredient is sulphur, and hence they are called sulphur casts. By this means the most curious antiques may, to all useful purposes, be indefinitely multiplied. The composition is thus described: melt eight ounces of sulphur over a gentle fire, and with it mix an equal quantity of fine vermillion, stir it well together, and it will dissolve like oil, then cast it into the mould, which is first to be rubbed over with oil. When cool the figure may be taken, and, touched over with aquafortis, it will look like fine coral.

BRIONIA *alba*, a root used in medicine, which has been long known to contain a considerable portion of starch, and a bitter principle soluble in water and alcohol. It has lately been examined by the French chemists by maceration, the starch was separated and obtained in a state of purity. The bitter principle appeared to possess the properties in a very pure state. It was also found to contain a considerable portion of gum, which is precipitated by the infusion of galls, and which Vauquelin denominates vegeto-animal matter, some woody fibre, a small portion of sugar, and a quantity of supermalate of lime, and phosphate of lime.

BRISTLE, a rigid glossy kind of hair, found on swine, and much used by brushmakers, shoe-makers, sadlers, and others. They are chiefly imported from Russia and Poland. There is a heavy duty upon these.

BRITTLENESS, a quality of certain bodies, by which they are subjected to be easily broken by pressure or percussion. Brittle bodies are extremely hard; a very small percussion exerts a force on them equivalent to the greatest pressure, and thus they are easily broken. This effect is particularly remarkable in glass suddenly cooled, the brittleness of which thereby is much increased. In the new arrangement of chemistry, the metals are distinguished into those that are more or less brittle as one of their leading characteristics.

BRIZA, in botany, a genus of the Triandria Digynia. Natural order of Gramina or Grasses. Essential character: calyx bivalve, many flowered; spikelet distinct, with heart-shaped obtuse valves, the lower of which is minute. There are six species, briza minor, small quaking grass, is an annual according to Linnæus and Villars: by Hudson, and in the Kew Catalogue it is marked as perennial. The culms are about a foot and a half in height; and the panicles are very much branched. Native of Germany, Switzerland, the South of France, Italy, and Britain. It flowers from June to August. B. media has a perennial root; culm upright, six or seven inches high in a dry soil, but in wet places it rises to two or three feet, having four or five knots on it. The panicle is handsome, spreads very much when in flower, and has two spikelets on each branch, placed on such long slender pedicles, as to shake with the least air or motion; each spikelet is composed of seven, eight, or nine florets, is heart-shaped, flatted, shining, smooth, varying in colours, usually variegated with green, white and purple. This beautiful grass is common in dry pastures in most parts of Europe. It flowers from May to July.

BROADSIDE, in the sea-language, denotes a volley of cannon, or a general discharge of all the guns on one side of a ship at once.

BROCADE, a stuff of gold, silver, or silk, raised and enriched with flowers, foliages, and other ornaments, according to the fancy of the merchants, or manufacturers.

BROCCOLI, a kind of cabbage cultivated for the use of the table. See BRASSICA.

BROKER, a name given to persons of several and very different professions, the chief of which are exchange-brokers, stock-brokers, pawn-brokers, and brokers, simply so called, who sell household furniture, and second-hand apparel.

BROKERS, *exchange*, are a sort of negotiators who contrive, make, and conclude

bargains between merchants and tradesmen, in matters of money or merchandize, for which they have a fee or premium. See Exchange.

Brokers, *insurance or policy,* are agents who transact the business of insurance between the merchant or party insured and the underwriters or insurers. These insurance brokers, from the nature of their employment, ought to be, and indeed generally are, persons of respectability and honour, in whom unlimited confidence may be reposed. To the broker the merchant looks for the regularity of the contract, and a proper selection of responsible underwriters: and to him also the underwriters look for a fair and candid disclosure of all material circumstances affecting the risk, and for the payment of their premiums. There is usually an open account between each broker and every underwriter with whom he has much dealing. In this account the broker makes himself debtor to the underwriter for all premiums, and takes credit for all losses to which the underwriter is liable, and which the broker is authorised to receive. Indeed, it is generally understood, that by the usage of trade in London, the underwriters give credit only to the broker for their premiums, and can resort only to him for payment, and that he alone, and not the underwriters, can recover the premiums from the insured. This point, however, has never been settled by any judicial determination. But though the underwriter thus looks to the broker for his premium, and though the broker, in his account with the underwriter, takes credit for the losses and returns for premiums, which he is authorised to receive from the underwriter, yet such losses are not to be regarded as a debt from the underwriter to the broker. Where the merchant happens to reside at a distance from the place where he means to be insured, the policy is usually affected by the mediation of his agent or correspondent there, who, if he be not a broker, employs one, and gives him all necessary instructions. In order to his being an agent in such a case, he must either have express directions from the principal to cause the insurance to be made, or else it must be a duty arising from the nature of his correspondence with the principal. And no general authority which he may have in relation to a ship or goods will make him an agent for the purpose of insuring, on behalf of the parties interested. However, though one man cannot, in general, compel another against his consent to become an agent for procuring an insurance to be effected for him, there are three cases, in which an order to insure must be complied with: as, first, where an agent has effects of his principal in his hands; secondly, where he has been in the practice of making insurances, and has given no notice to discontinue; and, thirdly, where he accepts bills of lading sent him on condition to insure. To the office of agent or broker, great responsibility attaches; and, in the execution of it, it is the duty of each to conduct himself with the greatest fidelity, punctuality, and circumspection. For in this, as in all other cases, where a man, either by an express or implied undertaking, engages to do an act for another, and he either wholly neglects to do it, or does it improperly or unskilfully, an action on the case will lie against him to recover a satisfaction for the loss or damage resulting from his negligence or want of skill. Hence, if a merchant here accept an order from his correspondent abroad to cause an insurance to be made, but limits the broker to too small a premium, in consequence of which no insurance can be effected, he is liable to make good the loss to his correspondent; for though it is his duty to get the insurance done at as low a premium as possible, yet he has no right so to limit the premium, as to prevent the insurance from being effected. And even a voluntary agent, who has no prospect of remuneration for his trouble, is liable, provided that he takes any step in the business. It is not only the duty of the agent, in transacting the business of insurances, to conduct himself with fidelity and punctuality towards his employer, but he is also bound to observe the strictest veracity and candour towards the insurer: for any fraud or concealment on his part will make void the policy, even though the insured be altogether ignorant and innocent respecting it. In an action against an agent or broker, whether for negligence or unskilfulness in effecting an insurance, the plaintiff is entitled to recover to the same amount as he might have recovered against the underwriters, if the policy had been properly effected. But he can only recover what, in point of law, he might have recovered on the policy; and not what the indulgence or liberality of the underwriters might probably have induced them to pay. In such an action, the agent may avail himself of every defence, such as fraud, deviation, non-com-

pliance with warranties, &c. which the underwriters might have set up in an action on the policy: but if the agent act in the usual manner, it will be deemed sufficient. There are many reasons why an agent or broker ought not to be an insurer. He becomes too much interested to settle with fairness the rate of premium, the amount of partial losses, &c.; and though he should not himself occasion any unnecessary delay or obstacle to the payment of a loss, he will not be over anxious to remove the doubts of others: besides, he ought not, by underwriting the policy, to deprive the parties of his unbiassed testimony in case of dispute. If an agent or broker, meaning to appropriate the premium to himself, and take the chance of a safe arrival, represent to his employer, that an insurance has been effected agreeably to his instructions, the principal may maintain trover for the policy against the agent or broker; and, upon proof of a loss, he shall recover to the same amount as he would have been entitled to recover against the underwriters, if a policy had been effected.

Brokers, *stock*, are those employed to buy and sell shares in the joint stock of a company or corporation, and also in the public funds. The negotiations, &c. of these brokers are regulated by several statutes, which, among other things, enact, that contracts in the nature of wages, &c. incur a penalty of 500*l.*; and by the sale of stock, of which the seller is not possessed, and which he does not transfer, a forfeit of 100*l.*; and contracts for sale of any stock, of which the contractors are not actually possessed, or to which they are not entitled, are void, and the parties agreeing to sell, &c. incur a penalty of 500*l.*; and that brokers keep a book, in which all contracts, with their dates and the names of the parties concerned, shall be entered, on pain of 50*l.*: these enactments, however, are little regarded by the gamblers in the public funds.

Brokers, *pawn*, are persons who keep shops, and let out money to necessitous people upon pledges, for the most part on exorbitant interest. These are more properly called pawn-takers, or tally-men, sometimes fripers, or friperers. Of these is to be understood the statute of 1 Jac. I. c. 21, by which it is enacted, that the sale of goods, wrongfully gotten, to any broker in London, Westminster, Southwark, or within two miles of London, shall not alter the property thereof. If a broker, having received such goods, shall not, upon the request of the right owner, truly discover them, how and when he came by them, and to whom they are conveyed, he shall forfeit the double value thereof to the said owner. But there are several excellent regulations respecting pawn-brokers of later date.

BROKERAGE, the fee paid to a broker for his trouble in negociating business between person and person.

BROMELIA, in botany, so named in memory of Olaus Bromel, a Swede, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Bromeliæ, Jussieu. Essential character: calyx trifid, superior; petals three, and a nectareous scale at the base of each; berry three-celled. There are nine species, one of which, B. ananas, or pine-apple, is a fruit now so well known in Europe, and so much esteemed for the richness of its flavour, is produced from an herbaceous plant which has leaves somewhat resembling those of aloe, and for the most part serrate on their edges, but much thinner and not so succulent as those of the aloe. The fruit resembles, in shape, the cone of some species of the pine-tree, from which it takes the vulgar name of pine-apple.

Where this plant is a native is difficult to determine, but it is probably an indigenous plant of Africa, where it grows in uncultivated places in great plenty. There are many varieties of this fruit, and if the seeds were sown frequently in their native country the varieties would probably be as numerous as those of apples and pears in Europe. The queen pine is the most common, but the sugar loaf is much preferable, the fruit being larger and better flavoured; it is easily distinguished from the others by its leaves having purple stripes on their inside the whole length, it is also of a paler colour when ripe, inclining to straw colour. This was brought from Brazil to Jamaica, where it is esteemed far beyond the others. The smooth pine is preserved by some curious persons for the sake of variety, but the fruit is not worth eating. The green pine is at present the most rare in Europe, it has been esteemed the best sort known by some of the most curious persons in America, many of whom have thrown out all the others to cultivate this only.

Those who wish to understand the propagation and culture of the pine-apple may consult Martyn's Botanical Dictionary with much advantage.

BROMUS, in botany, a genus of the

Triandria Digynia class and order. Natural order of Gramina or Grasses. Essential character: calyx two-valved; spikelet oblong, columnar, distich; awn below the top. There are twenty-five species.

The several species of this genus of grasses are numerous, and have not yet been well distinguised. They have a loose panicle like the oat, hence they have been called the oat-grasses; the awn or beard proceeds from the back of the glume or chaff, or is an elongation of the keel or mid-rib, as in the genus Avena; but in that the awn is commonly twisted, whereas in this it is straight; modern writers, therefore, distinguish them by the name brome-grasses. The festuca is scarcely different from bromus as a natural genus; in that, however, the chaff is either very much pointed, or terminates in an awn; but that of bromus always comes to the tip. The genus triticum, or wheat, agrees with it in this respect; and, therefore, some have thought there is no mark of distinction between them; it is, however, distinct in the inflorescence or manner of flowering in a spike; whereas bromus, festuca, and avena, bear their flowers in a panicle.

BRONCHIA, in anatomy, the ramifications of the trachea. See ANATOMY.

BRONZE, in the arts, a compound metal, composed of from 8 to 12 parts of tin combined with 100 parts of copper. It is of a greyish yellow colour, harder than copper, less liable to rust, and more fusible, so as to run thin, and be easily cast in a mould. Hence its use in casting statues. The metal of which the artillery is cast is of a similar composition, containing rather less tin. An alloy similar to bronze was much in use among the ancients, as well for warlike weapons as for medals, coins, &c.

BROOM. See GENISTA.

BROSIMUM, in botany, a genus of the Dioecia Monandria class and order. Essential character: male, ament globular, covered all round with orbiculate, peltate scales; corolla none; filament solitary, between the scales: female, ament as in the male; corolla none; style bifid; berry one-seeded. There are but two species. B. alicastrum is a tree frequent in the island of Jamaica. It is computed to make up about a third part of the woods in the parishes of St. Elizabeth and St. James. The timber is not much esteemed; but the leaves and young branches are more useful, being fattening fodder for all sorts of cattle. The fruit boiled with salt-fish, pork, beef, or pickle, is frequently the support of the negroes and poorer sort of white people in times of scarcity, and is a wholesome and not unpleasant food: when roasted, it eats something like our chesnuts, and is called bread-nut. B. spunium, is called milk-wood, and is common in St. Mary's parish, Jamaica. It rises to a considerable height in the woods, is reckoned among the timber trees, and is sometimes used as such, though not much valued.

BROSSÆA, in botany, so named from Guy de la Brosse, a genus of the Pentandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx fleshy; corolla truncate; capsule five-celled, many-seeded. There is but one species: *viz.* B. coccinea. An obscure plant, and the character doubtful, except what Plumier has said of it. In stature it is something like the codon. Branches alternate; leaves alternate, ovate, serrate, petiolate; flowers few, terminating the branches, alternate. It is a native of South America.

BROTERA, in botany, a genus of the Didynamia Gymnospermia. Calyx five-awned; middle segment of the lower lip of the corolla hodded, involving the stamina and style, and protruding them with a jerk. One species, B. persica, found in Persia.

BROWALLIA, in botany, given by Linnæus in honour of Job. Browallius, Bishop of Aboa, a genus of the Didynamia Angiospermia class and order. Natural order of Lunidæ. Scrophulariæ, Jussieu. Essential character: calyx five-toothed; corolla border five-cleft, equal, spreading, with the navel closed; anthers two larger; capsule one-celled. There are two species: B. demissa, spreading Browallia; and B. elata, upright Browallia. These are herbaceous annual plants, with alternate leaves. The flowers are either axillary or terminating. They have the habit of the solanaceous plants, and like them have the peduncle inserted either over against or at the side of the peticles. The former is a native of Panama, the latter of Peru. They both flower from July to September.

BROWNEA, in botany, from Dr. Patrick Browne, a genus of the Monadelphia Decandria. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx unequally bifid: corolla double; outer five-cleft; inner five-petalled: legume two-celled. There are two species: B. coccinea is a small tree, growing to the height of eighteen feet. When in flower it

has a beautiful appearance. The flowers grow about ten together, and are pendulous. The calyx is ferruginous, the corolla scarlet, the stamens yellowish. This species grows in hilly and woody places in America. B. rosa is also an American shrub, or small tree, with an ash-coloured bark, opposite leaves, which are entire and smooth on both sides. The flowers are borne in a kind of aggregate manner, so as to form heads or bunches of the size of one's fist. They are red, and make a very beautiful appearance. The stamens are extremely long. It grows chiefly in hilly situations.

BROWNISTS, a sect of Christians, the name given for some time to those who were afterwards known in England and Holland under the denomination of Independents. It arose from a Mr. Robert Brown, whose parents resided in Rutlandshire, though he is said to have been born at Northampton; and who from about 1571 to 1590 was a teacher amongst them in England, and at Middleburgh, in Zealand. He was a man of family, of zeal, of some abilities, and had a university education. The separation, however, does not appear to have originated in him; for by several publications of those times, it is clear that these sentiments had, before his day, been embraced and professed in England, and churches gathered on the plan of them.

This denomination did not differ in point of doctrine from the church of England, or from the other Puritans; but they apprehended that, according to scripture, every church ought to be confined within the limits of a single congregation, and have the complete power of jurisdiction over its members, to be exercised by the elders within itself, without being subject to the authority of bishops, synods, presbyteries, or any ecclesiastical assembly, composed of the deputies from different churches. Under this name, though they always disowned it, were ranked the learned Henry Ainsworth, author of the "Annotations on the Pentateuch," &c.; the famous John Robinson, a part of whose congregation from Leyden, in Holland, made the first permanent settlement in North America; and the laborious Canne, the author of the "Marginal References to the Bible."

BRUCEA, in botany, in honour of James Bruce, Esq. the famous traveller, a genus of the Dioecia Tetrandria class and order. Essential character: calyx four-parted; corolla four-petalled; female, pericarpium four, one seeded. There is but one species. B. ferruginea is a shrub of a middling size, with an upright stem; the bark is ash-coloured, branches few, alternate, round, patulous, and thick. Leaves alternate, spreading unequally pinnate, consisting of six pairs of opposite lobes, one foot in length. Spikes of male flowers solitary; the flowers are crowded together, either sessile or on very short pedicles, of an herbaceous colour, tinged with red or russet. It is a native of Abyssinia, where it is known by the name of wooginoos. The root is a specific in the dysentery. It is a plain, simple, bitter, without any aromatic or resinous taste, leaving in the throat and palate a disagreeable roughness.

BRUCHUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform; feelers equal, filiform; lip pointed. Gmelin enumerates 27 species. This genus consists in general of small insects. The B. granarius is found among beans, vetches, and other seeds, the lobes of which it devours. It is not the fourth part of an inch in length; black, with the wing-shells freckled by white specks: the two fore-legs are reddish; and the antennæ of a similar colour at the base: the thighs of the hind-legs are armed with a tooth or process. The exotic species are chiefly of America: one of the most remarkable is B. bactris, found in the nuts of the palm of that name.

BRUMALES, in botany, an epithet applied to plants which flower in our winter. These are common about the Cape.

BRUNFELSIA, in botany, so named in honour of Otho, or Otto Brunfelsus, a genus of the Didynamia Angiospermia. Natural order of Personatæ. Solaneæ, Jussieu. Essential character: five-toothed, narrow; corolla with a very long tube; capsule one-celled, many-seeded, with a very large fleshy conceptacle. There are two species, of which B. Americana is a tree growing from ten to fifteen feet in height. The trunk is smooth and even, and the branches loose. Leaves alternate, entire, smooth, and shining; corolla yellow, very sweet scented, having a tube four or five inches in length. It grows naturally in Jamaica, and most of the sugar islands in the West Indies, whence they call it trumpet flower. B. undulata is also a native of Jamaica.

BRUNIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Rhamni,

Jussieu. Essential character: flowers aggregate; filaments inserted into the claws of the petals; stigma bifid; seeds solitary, two-celled. There are three species. B. lanaginosa, heath-leaved Brunia, resembles Levisanus abrotanoides, and has the nectareous chink, as in that. The stem is about a foot high, and shrubby. The leaves linear-filiform, smooth, short, with black tips. The flowers, which are white, are borne in heads. B. ciliata, ciliate-leaved brunia, has the germ superior, and the style bifid. B. verticillata, whorled brunia, has small heads. They are all shrubs, and inhabitants of the Cape.

BRUNNICHIA, in botany, a genus of the Decandria Trigynia class and order. Calyx swelling, five-cleft; capsule three-sided, one-celled, many seeded. One species, B. cirrhosa, a native of Bahama.

BRUSH, an instrument made of bristles, hair, wire, or small twigs, to clean cloaths, rooms, &c. and also to paint with. There are various sorts of them, distinguished by their shape or use. In the choice of painter's brushes, observe whether the bristles are fast bound in the stocks, and if the hair be strong and lie close together; for if they sprawl abroad, such will never work well; and if they are not fast bound in the stock, the bristles will come out when you are using them, and spoil your work, as may be seen where the loose hairs of the brush have lain up and down in the colours laid on, to the great detriment of the work. Brushes in which the hairs are fastened with silver wire are very superior to those in which iron wire is used, especially where they are used in or with water. Brushes are used for medical purposes, in rheumatic affections of the joints, paralysis, &c. Mr. Thomason, of Birmingham, has a patent for hearth brushes, so constructed as to conceal the hair, by means of rack-work, in a metal case.

Brush, in electricity, denotes the luminous appearance of the electric matter issuing in a parcel of diverging rays from a point. Beccaria ascribes this appearance to the force with which the electric fluid, going out of a point, divides the contiguous air, and passes through it to that which is more remote.

BRUTA, in natural history, the second order of animals in the class Mammalia, the character of which consists in having no fore teeth in either jaw; feet with strong hooflike nails; motion slow; food mostly masticated vegetables. There are nine genera of this order, enumerated by Gmelin, *viz.*

Bradypus	Platypus
Dasypus	Rhinoceros
Elephas	Sukotyro
Manis	Trichechus.
Myrmecophaga	

BRUTE, or *beast*, a term generally applied to quadrupeds, and also to other animals, and implying inferiority of intellect.

Among brutes the monkey kind, both in the external shape and internal structure, bear the nearest resemblance to man. In the monkey kind, the highest and the most nearly approaching the likeness of man is the orang-outang, or homo sylvestris. Philosophers are much divided about the essential characters of brutes. Some define brute as an animal not risible, or a living creature incapable of laughter; others, a mute animal, or a living thing destitute of speech; the Peripatetics, an animal endowed with a sensitive power, but without a rational one. The Platonists allow reason and understanding, as well as sense, to brutes, though in a degree less pure and refined than that of men. Indeed, the generality of the ancient philosophers thought that brutes reasoned: this among the heathens, was the opinion of Anaxagoras, Porphyry, Celsus, Galen, Plutarch, as well as Plato and others.

That brutes possess reflection and sentiment, and are susceptible of the kind as well as the irascible passions, independently of sexual attachment and natural affection, is evident from the numerous instances of affection and gratitude daily observable in different animals, particularly the dog.

Of these, and other sentiments, such as pride, and even a sense of glory, the elephant exhibits proofs equally surprising and unquestionable; for which we refer to the article Elephas.

The brute creation manifests also a wonderful spirit of sociality, independent of sexual attachment. It is well-known that horses, which are perfectly quiet in company, cannot be kept by any fences in a field by themselves; oxen and cows will not fatten by themselves, but neglect the finest pasture that is not recommended by society: sheep constantly flock together. Nor is a propensity to associate restricted to animals of the same kind and size. Instances to this purpose are enumerated in "White's Natural History of Selborne," to which we refer the reader.

Mr. Locke maintains, that the souls of brutes are wholly material; that they do

not possess the power of abstraction; and that the having of general ideas is that which puts a perfect distinction between men and brutes. Accordingly, he supposes that they have no use of words, or any general signs, by which to express their ideas. It has, however, been a subject of dispute, whether brute animals have any language intelligible to one another. Some have pretended, that they have a kind of jargon, by which they can make a mutual communication of their sentiments. There is at least a similitude of speech in brutes; for they know each other by their voices, and have their signs whereby they express anger, joy, and other passions. Thus, a dog assaults in one strain, fawns in another, howls in another, and cries when beaten in another.

Dr. Hartley has investigated the intellectual faculties of brutes, and applied his theory of vibrations and association in accounting for the inferiority of brutes to mankind, with regard to intellectual capacities. He ascribes the difference subsisting between them to the following circumstances, which he has taken occasion to illustrate on the principles of this theory. The first of these is the small proportionate size of their brains, whence brutes have a far less variety of ideas and intellectual affections than men. The second cause of this difference is the imperfection of the matter of their brains, whereby it is less fitted for retaining a large number of miniatures, and combining them by association, than man's. The third cause is their want of words, and such like symbols. Fourthly, the instinctive powers which they bring into the world with them, or which rise up from internal causes, as they advance towards adult age, is another cause of this difference; and, fifthly, it is partly owing to the difference between the external impressions made on the brute creation, and on mankind. This ingenious writer supposes, with Des Cartes, that all the motions of brutes are conducted by mere mechanism; yet he does not suppose them to be destitute of perception; but that they have this in a manner analagous to that which takes place in us; and that it is subjected to the same mechanical laws as the motions. He adds, that it ought always to be remembered, in speaking on this subject, that brutes have more reason than they can show, from their want of words, from our inattention, and from our ignorance of the import of those symbols, which they do use in giving intimations to one another, and to us.

BRYONIA, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitaceæ. Essential character; calyx five-toothed; corolla five-parted: male, filaments three: female, style quadrifid. Berry subglobular, many seeded. There are nineteen species, of which B. alba, black berried white bryony, seems to differ from the red in little else besides the colour of the berries. Native of Sweden, Denmark, Cariola, and probably other parts of Europe, in hedges. B. dioica, red berried white bryony, is easily distinguished by its prodigious root, its stems climbing by tendrils, leaves resembling those of the vine in shape, not smooth as they are, but harsh and rugged, and of a paler colour, and by its bunches of small berries, which are red when ripe, and produced on a different plant from the male flowers. B. palmata, palmated bryony, has heart-shaped leaves, the side divisions shortest; the upper surface is marked with dots, very close, but scarcely visible: there are callous tubercles on the veins and peduncles. The berries are round and large. It is a native of the Island of Ceylon.

BRYUM, in botany, a genus of moss distinguished by a capsule covered with a lid, and over that a smooth veil. But these characters it has in common with Mnium and Hypnum, two other genera much resembling this. The peculiar mark of the bryum is, that the thread or little stem supporting the fructification, grows from a tubercle at the ends of the stem and branches.

BUBALUS, the *buffalo*, in zoology. See Bos.

BUBBLE, in philosophy, small drops or vesicles of any fluid filled with air, and either formed on its surface, by an addition of more of the fluid, as in raining, &c. or in its substance, by an intestine motion of its component particles.

Bubbles are dilatable or compressible, *i. e.* they take up more or less room, as the included air is more or less heated, or more or less pressed from without, and are round, because the included aura acts equally from within, all round; their coat is formed of minute particles of the fluid, retained either by the velocity of the air, or by the brisk attraction between those minute parts and the air.

The little bubbles rising up from fluids, or hanging on their surface, form the white scum at top, and these same bubbles form the steam or vapour flying from liquors in boiling.

Bubble, in commerce, a cant term, given to a kind of projects for raising of money on imaginary grounds, much practised in France and England, in the years 1719, 1720, and 1721.

The pretence of those schemes was the raising a capital for retrieving, setting on foot, or carrying on some promising and useful branch of trade, manufacture, machinery, or the like: to this end proposals were made out, shewing the advantages to be derived from the undertaking, and inviting persons to be engaged in it. The sum necessary to manage the affair, together with the profits expected from it, were divided into shares or subscriptions, to be purchased by any disposed to adventure therein.

Bubbles, by which the public have been tricked, are of two kinds, *viz.* 1. Those which we may properly enough term trading bubbles; and, 2. Stock or fund-bubbles. The former have been of various kinds; and the latter at different times, the most remarkable one in this country was that in 1720.

BUBO, in ornithology, the name by which zoologists call the great horned-owl, with a reddish-brown body. See Strix.

Bubo, in surgery, a tumour which arises with inflammation, only in certain or particular parts to which they are proper, as in the arm-pits and in the groins.

BUBON, in botany, a genus of the Pentandria Digynia. Natural order of Umbellateæ. Essential character: fruit ovate, striated, villose. There are five species, of which B. macedonicum, Macedonian parsley, it sends out many leaves from the root, the lower growing almost horizontally, spreading near the surface of the ground; the foot stalk of each leaf divides into several other smaller, garnished with smooth rhomb-shaped leaves, which are of a bright pale-green colour, indented on their edges. It is a native of Greece and Barbary. It flowers with us from June to August. In warm countries it is biennial, but in England the plants seldom flower till the third or fourth year from seed; but whenever they flower they always die. B. galbanum, lovage-leaved bubon, rises with an upright stalk to the height of eight or ten feet, having a purplish bark, covered with a whitish powder, which comes off when handled; the upper part of the stalk is covered with leaves at every joint, the foot stalks half embracing them at their base, branching out into several smaller, like those of the common parsley, and set with leaves like those of lovage, but smaller and of a grey colour. It flowers in August, but has not produced seeds in England. When any part of the plant is broken there issues out a little thin milk of a cream colour, which has a strong scent of galbanum. It is a native of the Cape of Good Hope.

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